Beaver-Camas Subbasin Assessment and Total Maximum Daily Loads

Department of Environmental Quality

May 3, 2005

Beaver-Camas Subbasin Assessment and TMDLs

May 3, 2005

Prepared by:
Melissa Thompson
Idaho Falls Regional Office
Department of Environmental Quality
900 North Skyline, Suite B
Idaho Falls, Idaho 83402

Acknowledgments

Gerald Messerli, Chairman of the Continental Divide Watershed Advisory Group, bestowed knowledge of the watershed and assisted with land access obtainment. Troy Saffle and of the DEQ-Idaho Falls Regional Office provided editorial reviews. Steve Robinson, Beneficial Use Reconnaissance Program (BURP) coordinator for the DEQ-Idaho Falls Regional Office, collected and supplied field data. Mark Shumar of DEQ-Technical Services provided a great deal of technical and field assistance. Dan Kotanski and Pat Koelsch, both of the Bureau of Land Management, provided water quality data, Proper Functioning Condition, and fisheries information. Lee Leffert, Brad Higginson, and Jim Capurso with the U.S. Forest Service (USFS) provided water quality, fisheries, and range management data for the subbasin. Jim Fredericks of Idaho Fish and Game (IDFG) supplied fish data.

Thank you all for contributing to the Beaver-Camas Subbasin Assessment and TMDL.

Cover photo provided by Idaho Department of Environmental Quality.

Table of Contents

List of Tables

List of Figures

List of Appendices

Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
µ	micro, one-one thousandth
§	Section (usually a section of federal or state rules or statutes)
ADB	assessment database
AU	assessment unit
AWS	agricultural water supply
BLM	United States Bureau of Land Management
BMP	best management practice
BOR	United States Bureau of Reclamation
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)
cfs	cubic feet per second
cm	centimeters
CWA	Clean Water Act
CWAL	cold water aquatic life
CWE	cumulative watershed effects
DEQ	Department of Environmental Quality
DO	dissolved oxygen
DOI	U.S. Department of the Interior
DWS	domestic water supply
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
F	Fahrenheit
FWS	U.S. Fish and Wildlife Service
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
I.C.	Idaho Code
IDAPA	Refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
km	kilometer
km^2	square kilometer
LA	load allocation
LC	load capacity
m	meter

m^3	cubic meter
mi	mile
mi^2	square miles
MGD	million gallons per day
mg/L	milligrams per liter
mm	millimeter
MOS	margin of safety
NA	not assessed
NB	natural background
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
PCR	primary contact recreation
PFC	proper functioning condition
ppm	part(s) per million
QA	quality assurance
QC	quality control
SBA	subbasin assessment
SCR	secondary contact recreation
SS	salmonid spawning
STATSGO	State Soil Geographic Database
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TP	total phosphorus
TS	total solids
TSS	total suspended solids
t/y	tons per year
U.S.	United States
U.S.C.	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
USGS	United States Geological Survey
WAG	Watershed Advisory Group
WBAG	*Water Body Assessment Guidance*
WBID	water body identification number
WLA	wasteload allocation
WQLS	water quality limited segment
WQMP	water quality management plan
WQS	water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and *biological integrity* of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are *water quality limited* (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses the water bodies in the Beaver-Camas Subbasin that have been placed on Idaho's current §303(d) list.

This *subbasin assessment* (SBA) and TMDL analysis have been developed to comply with Idaho's TMDL schedule. The assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Beaver-Camas Subbasin, located in southeastern Idaho.

The first part of this document, the SBA, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. Six segments of the Beaver-Camas Subbasin were listed on this list. The SBA examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

The Beaver-Camas Subbasin of southeastern Idaho (Figure A) is a watershed of the Upper Snake River Basin. This watershed is the easternmost in a series of five sinks drainages in the Upper Snake River Basin. The hydrology of the subbasin is dominated by both natural and human caused flow alterations, which contribute to limited beneficial use attainment in several 303(d) listed *reaches* in the watershed.

Data has been collected and analyzed to evaluate the scope of the water quality limiting issues on the 303(d) listed and non-listed streams in the Beaver-Camas Subbasin Creek Subbasin. Seven temperature TMDLs and one sediment TMDL, as summarized in Table A, have been developed from the results of the data, or in response to the data.

Table A. Streams and pollutants for which TMDLs were developed.

Stream	Pollutant(s)
Beaver Creek	Temperature
Camas Creek	Sediment, Temperature
Dairy Creek	Temperature
East Camas Creek	Temperature
Modoc Creek	Temperature
Threemile Creek	Temperature
West Camas Creek	Temperature

TMDLs for sediment are quantified through streambank erosion inventories. Sediment loading targets were developed based on literature detailing expected natural conditions and substrate sediment impacts on salmonid spawning. The target values established will be used to quantify streambank recovery and determine the need for additional management practices to improve water quality.

TMDL targets for substrate sediment are adopted from literature detailing its impact on salmonid egg and fry emergence. The target values established in this assessment will be used to indicate trends related to channel morphology and streambank recovery. Beneficial use support status and compliance with state water quality standards will be used to determine the need for additional best management practices to improve water quality.

Temperature TMDLs have been developed for all streams, where thermograph data has been collected, to support salmonid spawning and cold water aquatic life. Cold water aquatic life and salmonid spawning have been determined to be the presumed uses for all streams in the subbasin.

Reduced riparian vegetation contributes to accelerated streambank erosion, which results in increased thermal loading, which, combined with associated changes in channel morphology are the primary causes of increased temperature loading in affected streams.
Elevated temperatures from reduced riparian vegetation and accelerated streambank erosion have been exacerbated by an ongoing drought in the subbasin.

TDMLs were not developed for streams listed as flow altered. Streams listed as flow altered and streams discovered to be flow altered for significant portions of the year do not have a reasonable potential to support beneficial uses. The EPA does not believe that flow (or lack of flow) is a pollutant as defined by CWA Section 502(6). Since TMDLs are not required to be established for waterbodies impaired by pollution but not pollutants, TMDLs will not be developed for flow altered streams, at this time. They will be relisted as flow altered in subsequent integrated reporting events.

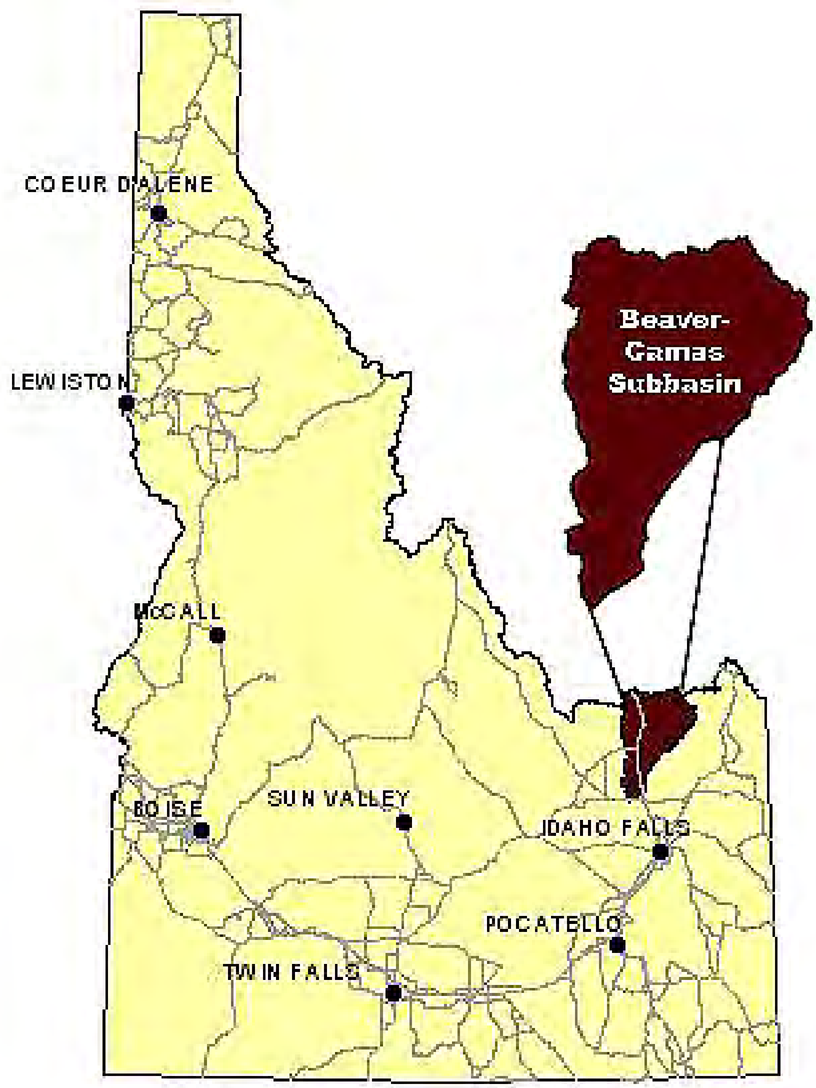


Figure A. Beaver-Camas Subbasin at a Glance

Key Findings

The hydrology of the Beaver-Camas subbasin is relatively complex, with a combination of gaining reaches in the upper elevations and losing reaches in the lower elevations. Hydrograph data show that a peak in flow is experienced in the early spring, when spring *runoff* peaks and surface water is able to reach the lower sections of the subbasin. Natural runoff flows are seen in the lower section of the subbasin for a short period of time during the peak runoff event. Natural infiltration into the basalt streambed is the causative agent for the absence of lower watershed flows. This is the natural hydrologic behavior of surface waters in the subbasin.

Land use in the subbasin is essentially split into two sections; the upper half of the subbasin is used for rangeland, and the lower section of the subbasin is utilized for crop production. The demand for surface water in the lower half of the subbasin is very high, therefore a complex system of irrigation canals have been developed for the transport of water. Since surface water is naturally infiltrating out of the stream, groundwater must be returned to Camas Creek to provide the necessary water for irrigation.

Since the lower sections of Beaver and Camas Creeks (303(d) listed) are naturally dry and have been converted into canal systems, TMDLs will not be developed for these listed sections.

Hydrology in the upper half of the subbasin is, for the most part, different than that of the lower half. Perennial flows are sustained in the majority of the streams and land management is focused towards rangeland grazing.

Riparian grazing is the principal source of temperature and sediment loading to the watershed. Riparian destruction leads to overall changes in channel morphology, sedimentation, and reduced stream shading, which leads to increased solar loading to the stream.

TMDLS are recommended for sediment and temperature impaired streams based upon the following criteria:

Temperature TMDLs have been developed for streams where temperature data has been collected and shows an exceedance of temperature criteria in greater than 10% of observation days during spring or fall spawning periods. Thermograph data established that temperature TMDLs were necessary to meet the numeric salmonid spawning criteria [IDAPA 58.01.02.250(02)]. All Temperature TMDL load reductions were developed by quantifying the solar radiation through solar pathfinder data, which measures the percent solar time. Percent solar time was converted into a solar load by multiplying the percent of solar time (April through September) by an average solar load in $kWh/m^2/day$. Streambank erosion, reduced riparian vegetation, and low flow conditions are the causes of increased water temperatures in the subbasin. The TMDL temperature targets are the salmonid spawning temperature criteria established in Idaho's administrative code [IDAPA 58.01.02.250(02)].

There are five 303(d) listed stream segments in the Beaver-Camas Subbasin and seven TMDLs established for streams in the subbasin. Some TMDLs have been established for non-listed streams since water quality data show that there is an exceedance of Idaho's water quality standards. Table B provides a summary of the assessment outcomes for each of the 303(d) listed segments and the unlisted segments receiving a TMDL.

Beaver Creek

There are two 303(d) listed segments on Beaver Creek. The listed segments are from Spencer to Dubois and from Dubois to Camas Creek. Pollutants for both of the listed segments are flow alteration, habitat alteration, nutrients, sediment, and temperature. Stream temperature data collected in and above Spencer show that temperatures exceed Idaho's numeric standard. Because of this, a temperature TMDL was established for Beaver Creek from Modoc Creek to I-15 Exit 172. Exit 172 is the endpoint for the TMDL since perennial flows are seldom seen below this point.

Water quality data show that sediment and nutrients are not definitively the sources of beneficial use impairment in the listed segment of Beaver Creek. Beaver Creek from Exit 172 to Camas Creek (mouth) is naturally devoid of flow, so it is proposed to be de-listed and re-listed as flow altered.

Camas Creek

Camas Creek is 303(d) listed from headwaters (Spring Creek confluence) to mouth. The listed pollutants for the upper segment of Camas Creek are flow alteration, nutrients, and sediment. Part of this section, above T9N, R37E, Section 16 (N44.19270°, W-111.98284°), is perennial. The lower half of this segment is flow altered (irrigation) and natural infiltration into the basalt stream bed is extensive as well. Riparian grazing has contributed to bank erosion and elevated stream temperatures. Sediment and temperature TMDLs have been calculated to address the pollutants of concern above T9N, R37E, Section 16.

The lower section of Camas Creek is 303(d) listed for flow alteration, habitat alteration, sediment, nutrients, and temperature. This section of Camas Creek is intermittent and flow altered for irrigation, therefore this segment should be de-listed for sediment, nutrients, and temperature and re-listed as flow altered.

Cow Creek

Cow Creek is 303(d) listed for an unknown pollutant. Cow Creek is an ephemeral stream and therefore should be de-listed for unknown pollutants. Ephemeral streams are not expected to support the same biological communities as perennial waters.

Dairy Creek, East Fork Camas Creek, Modoc Creek, Threemile Creek, West Fork Camas Creek

Dairy, East Fork Camas, Modoc, Threemile, and West Fork Camas Creeks are all streams that are not 303(d) listed. However, stream temperature data, collected on all five streams, showed that there were major exceedances in Idaho's numeric temperature criteria. Temperature TMDLs were established for all five streams.

Land management and land use in all of the streams is homogeneous with riparian grazing impacting overall stream health and water quality.

Table B. Summary of assessment outcomes.

Water Body Segment [WQLS]	Assessment unit of 17040214	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Beaver Creek* (Spencer to Dubois) **[2194]**	SK015_05	Flow	No	List below Exit 172 and de-list above Exit 172	Flow Altered (natural)
		Habitat	No	None	EPA Policy
		Nutrients	No	De-list	No Exceedances Documented
		Sediment	No	De-list	No Impacts Documented
		Temperature	Yes	None	Exceedances Documented
Beaver Creek* (Dubois to Camas Creek) **[2193]**	SK003_05 SK014_05	Flow	No	None	Flow Altered (natural and anthropogenic)
		Habitat	No	None	EPA Policy
		Nutrients	No	None	Flow Altered (natural and anthropogenic)
		Sediment	No	None	Flow Altered (natural and anthropogenic)
		Temperature	No	None	Flow Altered (natural and anthropogenic)
Beaver Creek (Headwaters to Spencer)	SK021_02 SK021_03 SK020_03 SK018_04 SK024_02	Temperature	Yes	None	Exceedances Documented
Camas Creek* (Spring Creek to Hwy 91) **[2191]**	SK002_05	Flow	No	List below T9N, R37E, Section 16 and de-list above	EPA Policy
		Habitat	No	None	EPA Policy
		Nutrients	No	De-list	No Exceedances Documented
		Sediment	Yes	None	Impacts Documented
		Temperature	Yes	None	Impacts Documented
Camas Creek* (Hwy 91 to Mud Lake) **[2190]**	SK001_06	Flow	No	None	Flow Altered (natural and anthropogenic)
		Nutrients	No	De-list	Flow Altered (natural and anthropogenic)
		Sediment	No	De-list	Flow Altered (natural and anthropogenic)
Cow Creek* (Headwaters to Thunder Gulch) **[5233]**	SK018_04	Unknown	No	De-list	Flow Altered (natural)
Dairy Creek (Headwaters to Mouth)	SK018_02	Temperature	Yes	None	Exceedances Documented
East Camas Creek (Headwaters to Mouth)	SK011_03 SK010_02 SK010_03	Temperature	Yes	None	Exceedances Documented
Modoc Creek (Headwaters to Mouth)	SK021_02	Temperature	Yes	None	Exceedances Documented
Threemile Creek (Headwaters to Mouth)	SK017_02 SK017_03	Temperature	Yes	None	Exceedances Documented
West Camas Creek (Headwaters to Mouth)	SK012_03 SK013_02 SK013_03	Temperature	Yes	None	Exceedances Documented

*1998 303(d) listed segment

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. (In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.)

This document addresses the water bodies in the Beaver-Camas Subbasin that have been placed on Idaho's current §303(d) list.

The overall purpose of the subbasin assessment (SBA) and TMDL is to characterize and document pollutant loads within Beaver-Camas Subbasin. The first portion of this document, the SBA, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the Beaver-Camas Subbasin (Section 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years, as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (EPA must approve Idaho's water quality standards). Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. *The Beaver-Camas Subbasin Assessment and TMDLs* provides this summary for the currently listed waters in the Beaver-Camas Subbasin.

The SBA section of this document (Sections 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Beaver-Camas Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." However, TMDLs are not required for water bodies impaired by pollution, but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include the following:

- Aquatic life support–cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation–primary (swimming), secondary (boating)
- Water supply–domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

A SBA entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

1.2 Physical and Biological Characteristics

The Beaver-Camas Subbasin is located in southeastern Idaho, near the Montana border. This watershed has a complex geologic past that has resulted in the development of a disconnected drainage. Surface water is principally sourced by snow pack, resulting in high runoff peaks in the spring and dry streambed conditions in the fall.

Climate

The climate of Idaho is primarily influenced by air masses moving inland from the Pacific Ocean (Godfrey 1999). Eastern Idaho tends to be more continental in character than western or northern Idaho (Godfrey 1999), resulting in a greater range between winter and summer temperatures. In summer months, rainfall, cloud cover, and relative humidity are at a minimum due to the weakening of the westerly winds, allowing continental climate conditions to prevail. (Abramovich *et al*. 1998)

The main source of Idaho's moisture is the maritime air from the prevailing westerly winds. Precipitation in southeastern Idaho tends to peak twice annually, first in late spring and second in late fall. Summers present the least precipitation, with zero precipitation frequently recorded in August. Convection thunderstorms during spring and summer months also contribute to precipitation in the subbasin. (Abramovich et al. 1998)

Table 1 lists the weather stations in the vicinity of the Beaver-Camas watershed, showing the period over which the station has recorded data, the geographic location of the station, and the elevation at which the station is located. The Kilgore station is the northernmost station in the basin and the Hamer station is the southernmost, as shown in Figure 1. Average summertime temperatures are highest in Hamer averaging 87.7°F in July. Average summertime maximum temperatures occur in Kilgore an averaging 77.6°F in July (Tables 2-4).

Table 1. Weather Stations located in the Beaver-Camas Subbasin.

Station Name	Station ID #	Period of Record	Latitude	Longitude	Elevation (ft)
Dubois Experiment Station	102707	01/01/25 to 12/31/03	44°15'	112°12'	5445
Hamer, 4 NW	103964	10/25/48 to12/31/03	43°58'	112°16'	4790
Kilgore	104908	11/01/60 to 09/03/77	44°24'	111°53'	6160

Tables 2 through 4 provide monthly and annual climate statistics for the three weather stations located in the subbasin. Figures 1 through 3 show average daily temperatures and average daily precipitation for the Dubois, Hamer, and Kilgore weather stations. As shown by the weather stations, temperatures follow the expected pattern, peaking in late July and early August and reaching minimum temperatures in the latter part of December through January. Temperatures are highest in the southern portion of the subbasin, which is a lower elevation and is characterized as a semi-arid steppe. The higher elevations, in the northern portion of the subbasin, experience cooler temperatures (by a rough average of four degrees) in the summer months. Interestingly, mean minimum temperatures are lowest in Dubois, averaging roughly four degrees cooler in than in Kilgore in January.

Precipitation in the watershed varies from nine inches per year in the lower more arid regions to 43 inches per year in the high elevation, mountainous regions along the continental divide (Figure 4). The precipitation is relatively evenly distributed throughout the year with slight increases during the winter and again in May and June. Abramovich et al. (1998) indicate that southeastern Idaho is somewhat unique with these two precipitation peaks as compared to the rest of the state, which typically has one winter peak in precipitation.

The annual average snowfall for the subbasin varies from 28.4 inches in Hamer (Table 3) to 42.8 inches a Kilgore (Table 4) with the majority of the snowfall occurring between November and March. Snow-pack tends to be greatest at the upper end of the subbasin and decreases towards the south, consistent with elevation. Light snowfall begins in September and October throughout the subbasin with snow events continuing through the springtime and ending in June.

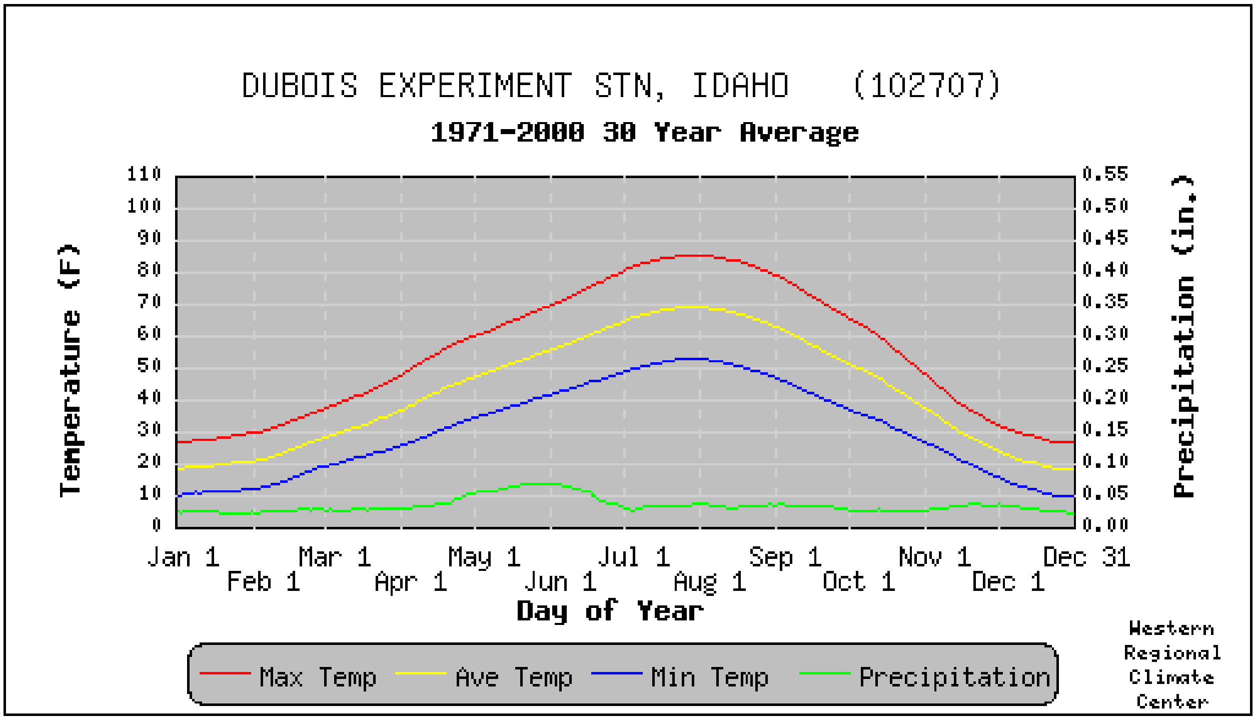


Figure 1. 30-Year Average Daily Temperature and Precipitation for Dubois Weather Station.

Table 2. Period of record monthly climate summary for the Dubois weather station.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ave Max Temp (°F)	27.1	32	40	54.5	65.5	74.4	85.4	83.8	72.8	58.4	39.7	29.7	55.3
Ave Min Temp (°F)	10.3	14	20.5	29.9	38.3	44.9	52.3	50.5	42.1	32.8	21.6	13.3	30.9
Ave Tot Precip (in)	0.76	0.72	0.75	0.99	1.66	1.75	0.84	0.91	0.88	0.81	0.89	0.9	11.9
Ave Tot Snowfall (in)	10.5	8.9	5.4	2.1	0.9	0.1	0	0	0.1	1.3	6.3	11.9	47.6
Ave Snow Depth (in)	10	13	7	0	0	0	0	0	0	0	1	6	3

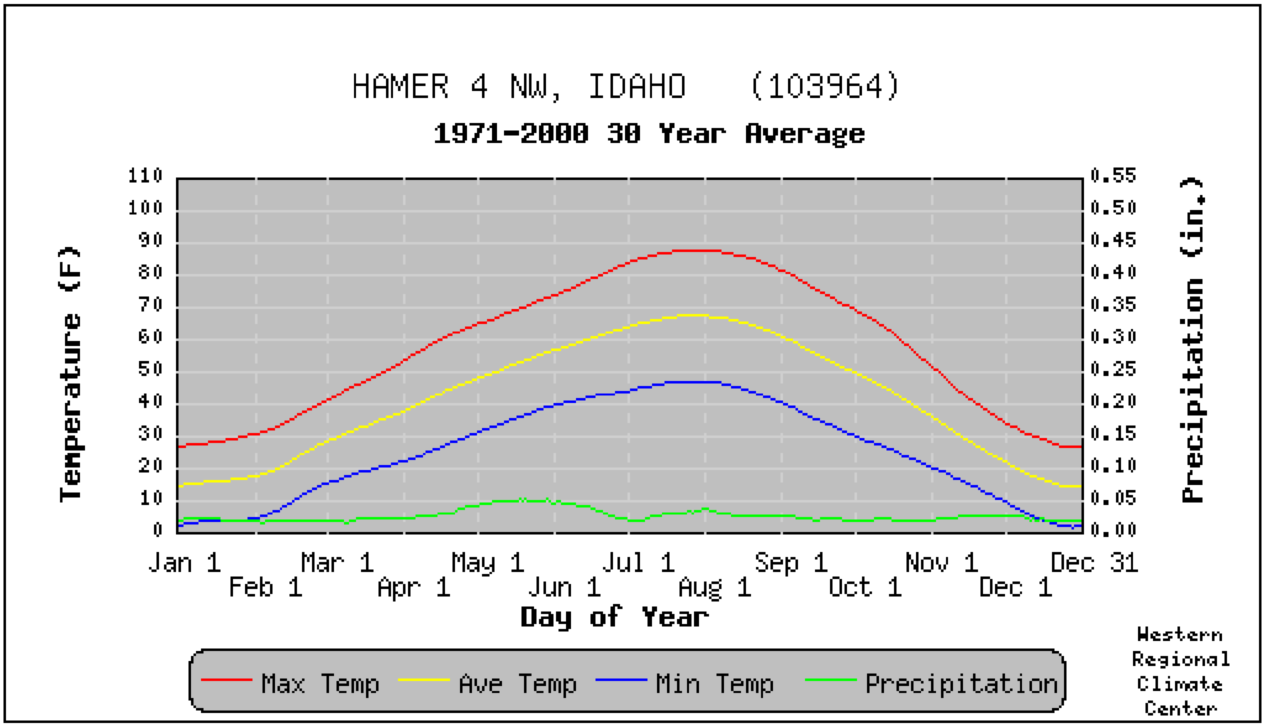


Figure 2. 30-Year Average Daily Temperature and Precipitation for Hamer Weather Station

Table 3. Period of record monthly and annual climate summary for the Hamer weather station.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ave Max Temp (°F)	28.3	34.6	45.8	59.3	69.7	78.4	87.7	86.3	75.8	62.2	43	30.3	58.4
Ave Min Temp (°F)	4.2	9.7	18.5	27.1	36.1	43	47.8	45.7	36.9	26.6	16.5	6.4	26.5
Ave Tot Precip (in)	0.57	0.48	0.57	0.78	1.36	1.22	0.72	0.70	0.59	0.58	0.66	0.64	8.87
Ave Tot Snowfall (in)	6.8	5.2	2.7	1.1	0.4	0	0	0	0.1	0.8	3.4	8	28.4
Ave Snow Depth (in)	6	5	2	0	0	0	0	0	0	0	0	4	1

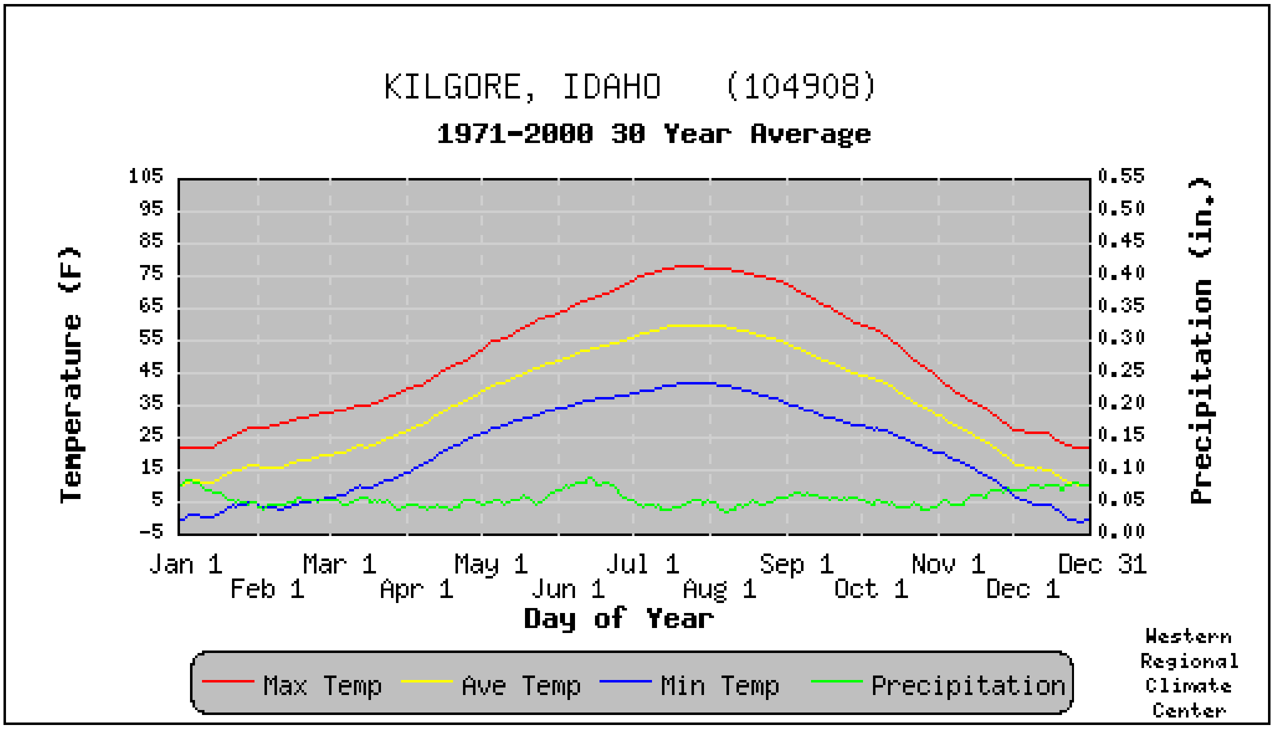


Figure 3. 30-Year Average Daily Temperature and Precipitation for Kilgore Weather Station.

Table 4. Period of record monthly and annual climate summary for the Kilgore Weather Station.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ave Max Temp (°F)	23.7	30.8	35.3	45.4	58.9	67.4	77.6	76.5	66.1	53.9	36.6	25.9	49.8
Ave Min Temp (°F)	1.9	5	8.3	20.5	30.8	37.3	40.6	39.3	31.9	24.2	15.5	40	21.6
Ave Tot Precip (in)	2.28	1.47	1.53	1.34	1.89	2.93	1.13	1.49	1.62	1.16	1.99	2.3	21.1
Ave Tot Snowfall (in)	28.9	17.1	15.6	9.2	1.3	0.4	0	0	1.4	4.1	19.6	33.9	132
Ave Snow Depth (in)	26	29	32	15	1	0	0	0	0	0	4	15	10

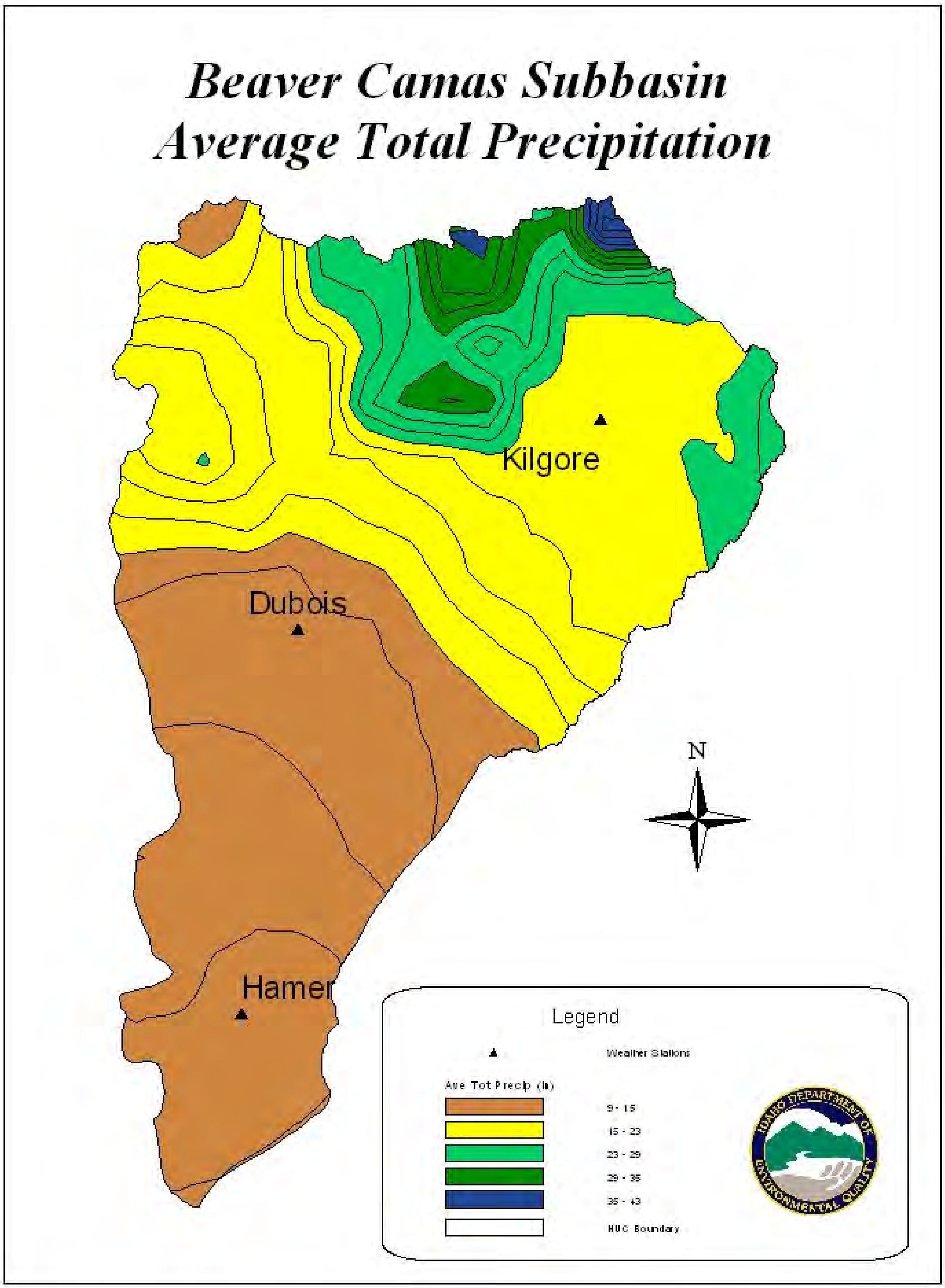


Figure 4. Beaver-Camas Subbasin Total Annual Precipitation and Weather Station Locations.

Air Temperature

Maximum daily air temperatures (°F) were examined at two United States Bureau of Reclamation (BOR) Pacific Northwest Region Hydromet System Data (Agrimet) stations near the Beaver-Camas Subbasin. One station is in Rexburg, Idaho and a second station is in Ashton, Idaho.

For each of these two stations, seven-day moving averages were calculated for all mean daily air temperatures on record (Table 5). From these data, the maximum seven-day moving average was calculated for each year on record. Then the 90th percentile of the maximum annual seven-day averages was calculated. Finally, the number of times the 90th percentile value was exceeded by maximum daily air temperatures was determined for the entire record (minimum of ten years).

The 90th percentile of seven-day moving averages of the maximum daily air temperatures was lowest at Ashton and highest at Rexburg, and the differences are slight but, similar to what might be expected due to differences in elevation.

Table 5. Mean maximum daily air temperature data for two Agrimet Stations.

Ashton, Idaho	
Period of Record	01/01/88 to 12/31/03
90th Percentile of 7-day moving average	96.57°F
Number of times 90th percentile exceeded during period of record	3
Rexburg, Idaho	
Period of Record	01/01/88 to 12/31/03
90th Percentile of 7-day moving average	97.53°F
Number of times 90th percentile exceeded during period of record	4

Snow Water Content

There are two Natural Resources Conservation Service (NRCS) Snotel sites (sites outfitted with special weather stations that measure snow water content) within the vicinity of the Beaver-Camas Subbasin (Figures 5-7). The Island Park site is east of the Subbasin in the Upper Henry's watershed. The other site, Crab Creek, is located in the Beaver-Camas watershed, northwest of Kilgore.

Snotel Graphs shown in Figures 5 through 7 show snow water content at the two sites. The Crab Creek site is newer, with a period of record from 1998 to present whereas the Island Park site's period record is longer, spanning 1983-2004. These graphs show daily average snow water content (heavier blue line) superimposed over the precipitation (green line) and temperature (red line). As illustrated in Figures 5 through 7, snow water content at Island Park was highest in 1983, 1995, and 1997 (25 in) with snow water contents measured above 20 inches. The lowest snow water content years in Island Park occurred in 1997 and 2001 with measurements at or below 10 inches. The Crab Creek monitoring site has limited data with no measurements recorded in 2001, however, from the data at hand, it is shown that the highest snow water content was recorded in 1999 (around 20 in) and the lowest snow water content year recorded was 2003 (around 10 in).

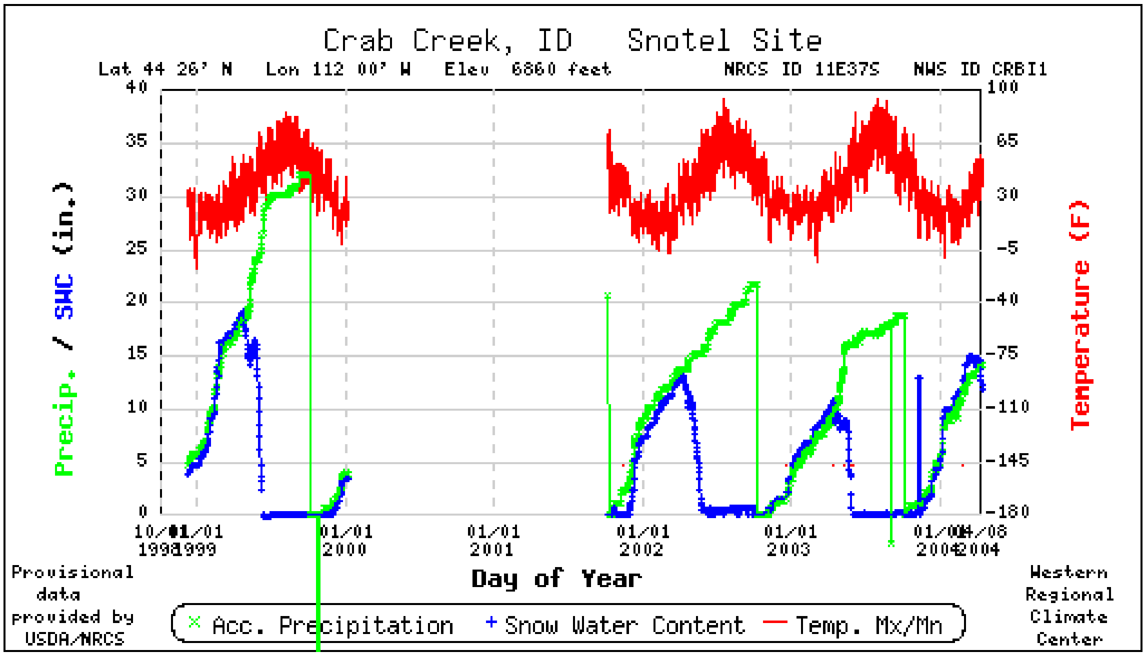


Figure 5. Snotel Graph for Period of Record at the Crab Creek Monitoring site.

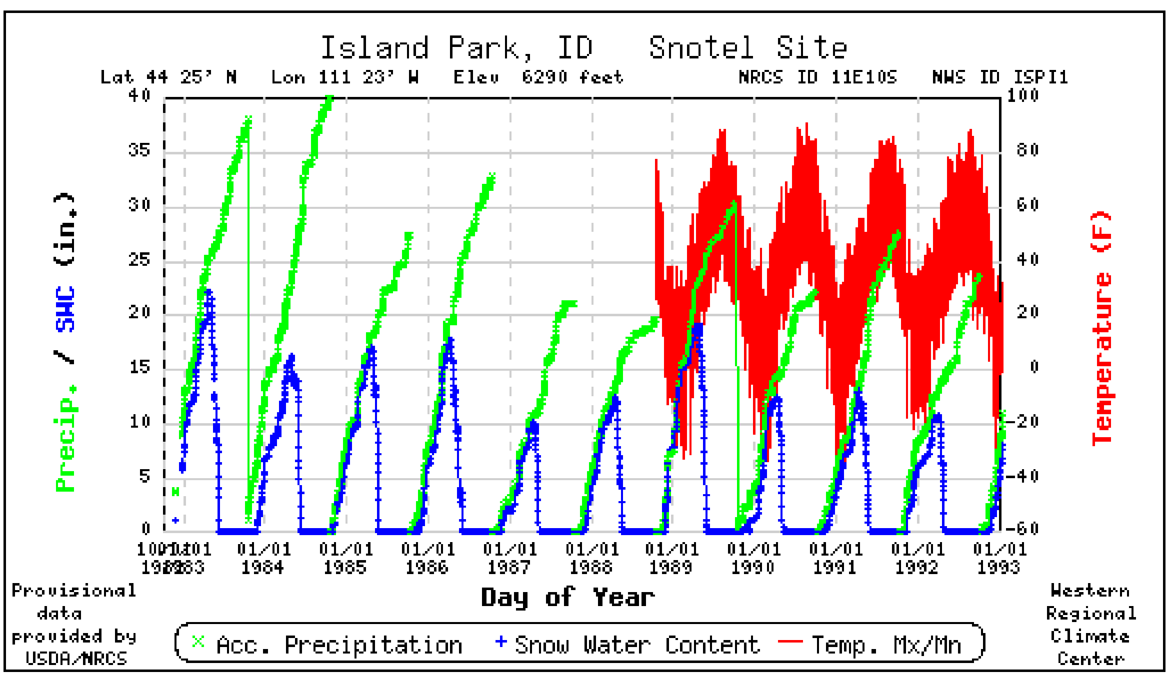


Figure 6. Snotel Graph for 1983 through 1993 at the Island Park Monitoring Site.

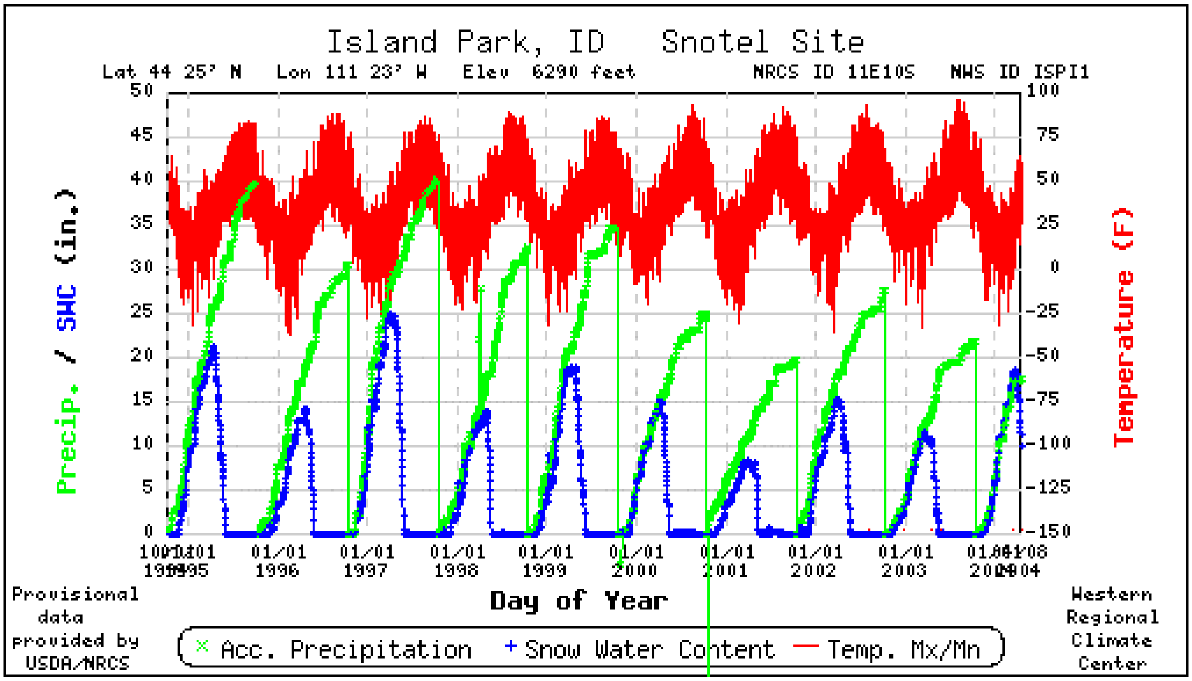


Figure 7. Snotel Graph for the Period of 1994 through 2004 at the Island Park Monitoring Site.

Subbasin Characteristics

Setting and Topography

The topography of southern Idaho is varied and dramatic. The fundamental reasons for this diversity are geological: the recency of volcanism and uplift of ranges along normal faults. This rough topography reflects a complex geologic past.

The Beaver-Camas Watershed is the eastern-most of the local Central Valleys watersheds that collectively make up the Sinks Drainages. The Medicine Lodge Creek, Birch Creek, Little Lost River, and Big Lost River respectively, are located to the west and make up the remaining watersheds of the Sinks Drainages. These watersheds are contained within the Basin and Range province, which occupies a small area of southern Idaho between the Middle Rocky Mountains and the Snake River Plain, west of the northern bound of the Central Rocky Mountains. These are the watersheds that disappear into valley fill material of the longitudinal valleys formed by the Pioneer Range, White Knob Mountains, Lost River Range, Lemhi Range, and the Beaverhead Range of the Basin and Range province.

The Beaver Camas Watershed drains an area of 64,3083 acres (1005 mi^2) bounded by the western edge of the Centennial Mountains and the Eastern Edge of the Beaverhead Mountains in the northern region of the subbasin and drains to the valley floor.

The Beaver-Camas watershed lies in the northeastern corner of the Snake River Plain. The Snake River Plain was formed by the Yellowstone Hot Spot. This is an ancient system of volcanic formations resulting from the North American Plate moving southwest over a stationary-melting anomaly in the earth's mantle commonly referred to as the Yellowstone Hot Spot.

The Hot Spot is characterized by high topography, related to high subsurface heat flow and volcanic activity. The melting anomaly in the mantle results in the inflation, or elevation of the earth's crust, which produces the Continental Divide and also produces other features important to the surrounding hydrology, such as active fault zones, earthquakes, and hot springs (Link 2003). In the wake of the Hot Spot is a path of subsided/deflated terrain that forms the Snake River Plain. This subsidence was due to cooling of the crust and the volcanic infusion of heavy material into the lower and middle crust, resulting in sinking of the Plain relative to the surrounding topography.

As the North American Plate migrated over the Hot Spot, the surface hydrology radiated away from the area of the melting anomaly. This can be seen in the present day location of the Hot Spot in the Yellowstone area, whereas the location of the Hot Spot approximately 6.5 to 10 million years ago would have caused the waters of the Central Valleys to drain northward into the historic Salmon River drainage. This relationship may have caused the Big Lost to drain into the ancestral Salmon River drainage. The Little Lost would have flowed into the ancestral Pahsimeroi subwatershed, and Birch Creek would have flowed into the ancestral Lemhi watershed. In the wake of the Hot Spot, the topography subsided, or deflated, changing the predominant valley slope aspect from north to south and the adjacent Central Valley drainages were captured. The flow from the captured drainages changed to the south, toward the Snake River Plain, isolating the drainages from the ancestral Salmon River creating what we know today as the Sinks Drainages (Link 2003).

Approximately 6,000 years ago, a wetter climate prevailed in this region and, in conjunction with glacial melt off and higher average precipitation, lakes were present in troughs that resulted from the subsidence of the earth's crust. Lake Terreton formed in what is known as the Big Lost Trough. It received the flow of the Big and Little Lost Rivers. Mud Lake formed in the Mud Lake Basin and received flow from Birch, Medicine Lodge, and Camas Creeks. During flood years, the lakes were likely connected with the headwaters of the ancestral Henry's Fork of the Snake River. These connections between the various surface waters of the region could have been the mechanism that inoculated the Sinks Drainages with fish as recently as 5,000 to 6,000 years ago. Today, due to dryer conditions, all that remains of these lakes are the ephemeral playa systems that can be seen from the air over the northern Snake River Plain. The Playas, or lakebeds, as they exist today have been essentially unchanged for approximately 1,000 years (Link 2003).

Volcanic Rift Zones developed when lava flowed down along the axis of the longitudinal valleys of the Big Lost and Little Lost Rivers into the basins in the Snake River Plain that eliminated the connectivity between the trough lakes. The Rift Zones are the linear features that are oriented north to south along the normal faults that form their respective valleys. To the south of the Volcanic Rift Zones are holistic domes that form the buttes that are prominent in the Snake River Plain south of the Lost Rivers. These holistic domes squeezed up through the basaltic lava flows along a feature called the axial volcanic high. The axial volcanic high is 1 million years old, and separates the Sinks drainages from the Snake River Plain and, subsequently, the Snake River.

Geology

The Beaver-Camas Subbasin includes portions of the Northern Rocky Mountain physiographic province and the Eastern Snake River Plain section of the Colombia Intermountain physiographic province.

The Northern Rocky Mountain physiographic province is characterized by a number of mountain ranges and intervening valleys that have developed on the Idaho batholith and other subsidiary igneous intrusions. These mountain ranges, which include the Beaverhead Range in the northeastern portion of the Subbasin and the Centennial Range in the northwestern portion of the Subbasin, consist of metamorphic and sedimentary rocks of Precambrian to Mesozoic age that have been subjected to intensive uplifting, faulting, and folding. Within the Subbasin, most of these deformed metamorphic and sedimentary units have been covered with a veneer of volcanic hyalite, basalt, and welded tuff. In the late Cenozoic Era, during the later stages of the building of the mountain ranges of the Northern Rocky Mountain province, the mountain province was dissected by an extensive rifting in the earth's crust which created a broad trough that filled with volcanic rocks. This trough, which extends in an accurate pattern across southern Idaho, is known as the Snake River Plain. The basalt flows that underlie the Snake River Plain are many thousands of feet thick. Over much of the southern portion of the subbasin, the basalt has been covered with a veneer of wind blown sediments. In the southern tip of the subbasin, in the Mud Lake/Terre ton area, the basalt has been covered with lake sediments left behind as the Pleistocene age Lake Terre ton evaporated, leaving Mud Lake as its remnant. Figure 8 displays the dominant geology types in the watershed.

Generally, geology in the Beaver-Camas Watershed is volcanic with the exception of a small area in the northern portion of the basin near Monida Pass, which is located at the continental divide on I-15, along the western edge of the Centennial Mountain Range. This portion of the watershed is an assortment of sedimentary formations intruded by granite. (Alt and Hyndman 1989)

The landscape is dominated by more recent basalt lava flows that erupted just thousands of years ago, as the Basin and Range faults formed the Snake River Plain. Basalt flows overlay older rhyolite, a remnant of the passing of the Yellowstone hotspots. (Alt and Hyndman 1989)

Opal, a variety of silica, is located in the northern region of the watershed, east of Spencer. The precious opal found in the Spencer Mines is formed when, "silica gel precipitates very slowly from absolutely quiet water that fills holes deep in the volcanic rock" (Alt and Hyndman 1989, p. 258). Under these conditions, microscopic spheres of silica gel coagulate and line up in rows and layers. This condition creates a prism, diffracting rays of light glistening rainbow colored rays of light.

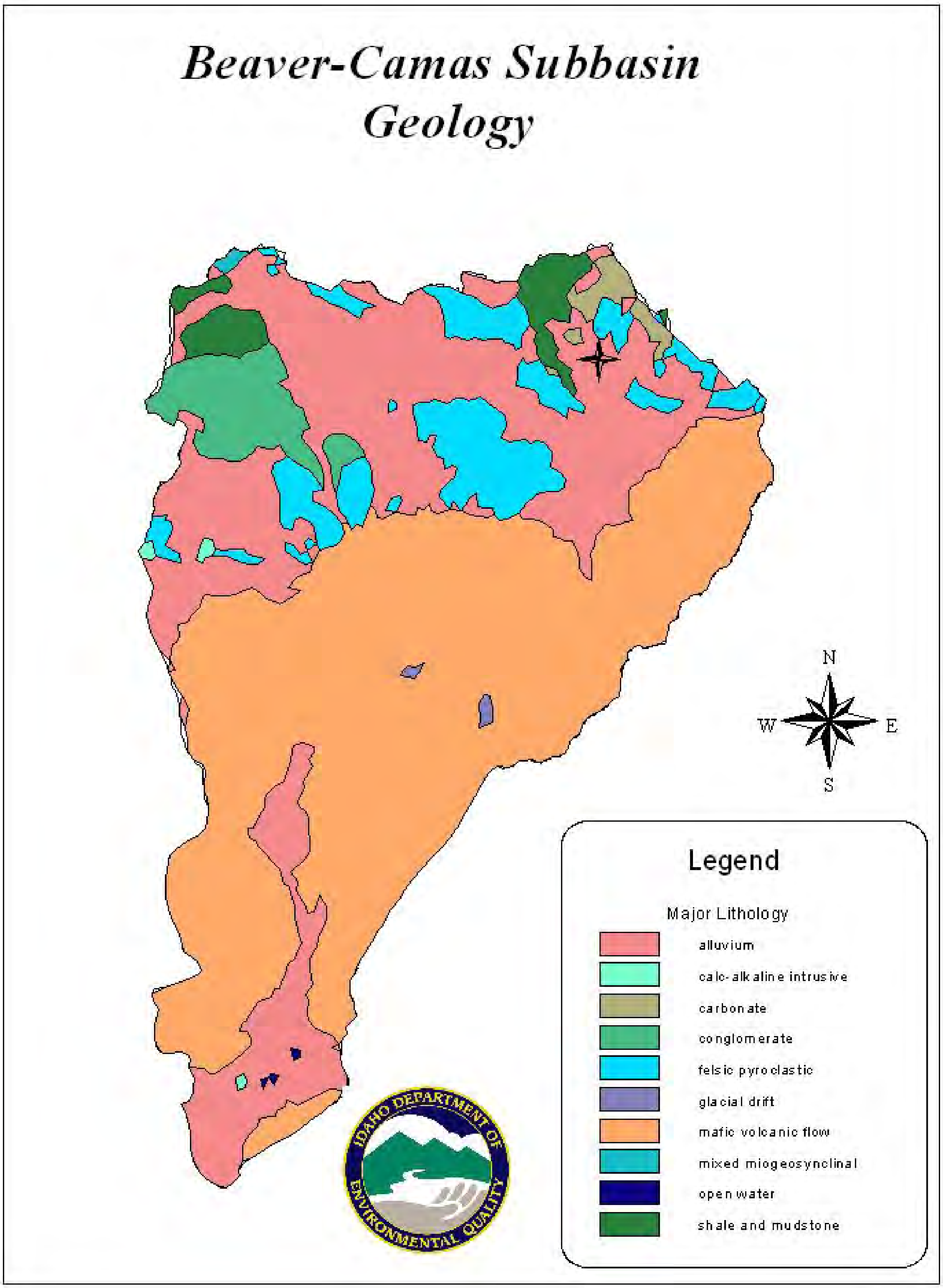


Figure 8. Beaver-Camas Subbasin Geology.

Soils

Soils in the Beaver-Camas subbasin are principally divided into three locales, which strongly correlate with the subbasins' diverse topographic and geologic characteristics. Soils range from silty clay loam in the very southern tip of the watershed, around Mud Lake, to fine sandy loam, in the central portion of the watershed, and to gravely loam in the upper mountainous portion of the watershed. Generally, soils in the watershed are deep to very deep and moderately to excessively well-drained. Soils in the upper watershed, near the continental divide, were formed in loess, influenced by valley side alluvium. In the central portion of the watershed, soils were formed from wind worked materials and Elian deposits overlaying basalt planes. Soils in the lowermost portions of the watershed, near the Mud Lake area, are derived from fluvial and lacustrine deposits.

There are about 643,083 acres within the Beaver-Camas Subbasin delineation. Soils in the project area are described by generalized soil map units called STATSGO Map Units or Map Unit Identification Numbers (MUID), from the **Stat**e **S**oil **Geo**graphic Database. STATSGO is compiled by generalizing more detailed soils maps. The fifteen STATSGO map units (MUID) comprised by this acreage are shown in Figure 9, and are summarized in Table 6. The summary of the STATSGO data found in Table 6 contains average soil slope, soil depth, average K factor, permeability, and percent clay. These are weighted averages for the entire polygon of the MUID.

K-Factor is a measure of erodibility used in the Universal Soil Loss Equation. It measures the tendency of a soil to erode based on the soil texture, organic matter content, soil structure, and permeability. Soils are given a score from 1.0 to 0.1, where 1.0 is extremely erosive and 0.1 is nearly non-erosive. As shown in Figure 10, soils in the watershed have a low to moderate K-factor with the most erosive soils (0.35-0.45) occurring in the northwestern corner of the subbasin (ID172), in the Modoc Creek and upper Beaver Creek watersheds. The least erosive soils (0-0.08) are located in the mountains along the continental divide, where rocky outcrops provide substantial protection against erosive forces. With the exception of the tip of the watershed, at the continental divide, and the base of the watershed at Mud Lake, the soil's erosive potential tends to decrease as one moves down the watershed.

Soil slope represented on STATSGO map units is shown as a percentage in Figure 11. Soil slope is another factor in assessing the erodibility risk of a system. As expected, the steepest slopes in the subbasin were located along the continental divide averaging 52%. Generally, surface slope decreases down the watershed with a surface slope of 0.5% in the Mud Lake area.

Figure 12 depicts soil units on soil depth in inches. The deepest soils are located in MUID ID172, where the headwaters for Beaver Creek and the Modoc Creek drainage are located. The shallowest soils are exhibited in MUID ID165 in the central portion of the watershed where soils are comprised of wind blown deposits on basalt planes.

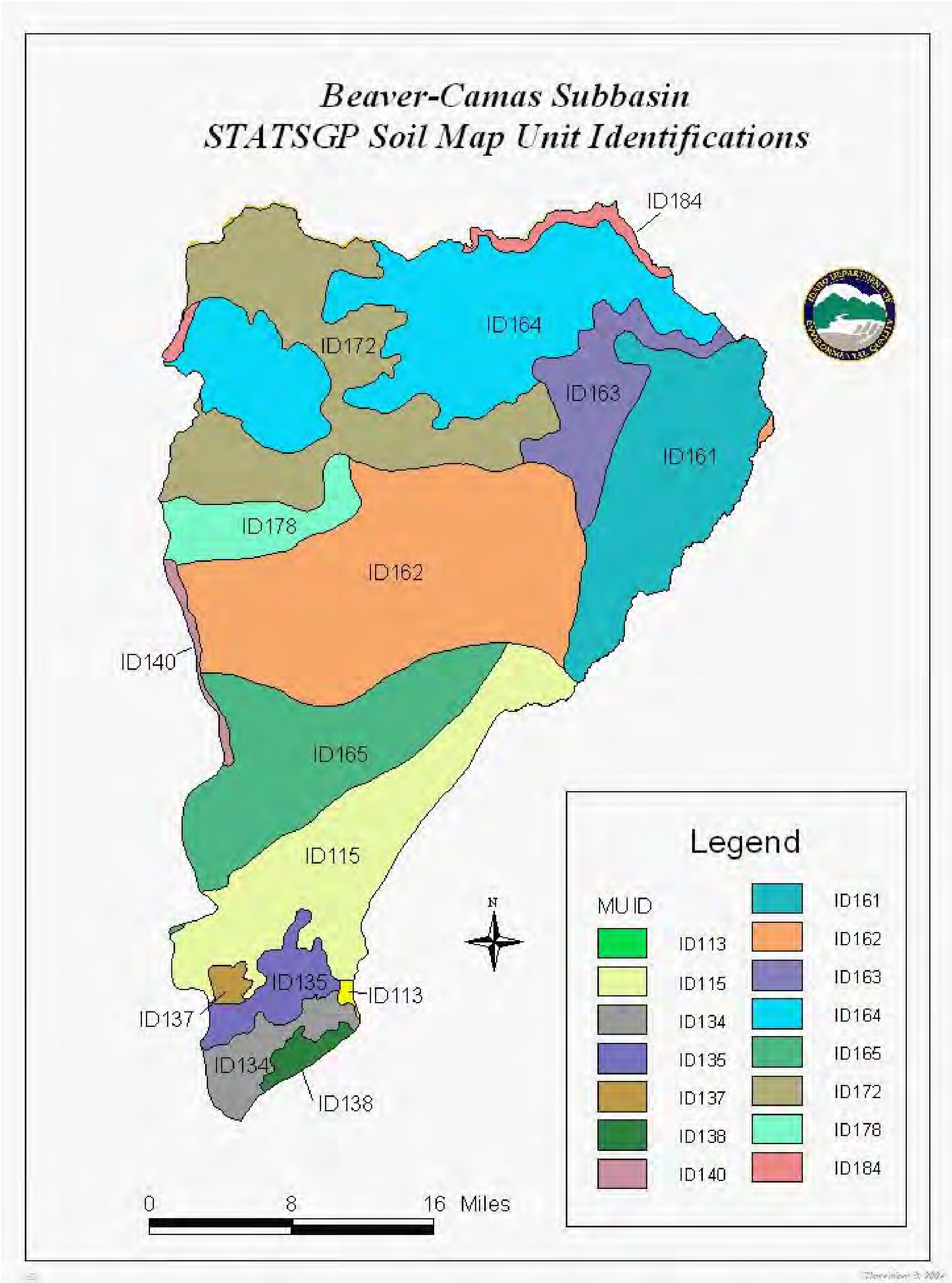


Figure 9. STATSGO Soil Map Unit Identifications.

Table 6. Beaver-Camas STATSGO Soil data Summary.

MUID	Name	Description	Ave Slope (%)	Permeability (in/hr)	Soil Erosion Potential (K-Factor)	%Clay	Thickness (in)
ID113	Rock Outcrop-Bondranch-Modkin	Sandy loam to coarse loam, overlaying basalt bedrock, well drained soils on basalt planes with slopes from 0-30%.	19.5	3.85	0.15	11.3	49.8
ID115	Diston-Grassey Butte-Zwiefel	Sandy, deep to moderately deep, excessively drained soils in eolian deposits of mixed origins on basalt planes.	7.5	8.9	0.12	9.5	57.8
ID134	Terreton-Zwiefel-Montlid	Silty clay loam. Deep moderately well drained soils that formed in lacustrine material. Playas and have slopes from 0-1%.	0.1	1.2	0.33	37.5	60
ID135	Levelton-Medano-Fluvaquents	Fine sandy loam, deep, very poorly drained soils that formed in lacustrine sediments, lakebeds, flood planes and at the ends of alluvial fans.	0.5	3.92	0.24	27.9	60
ID137	Aecet-Rock Outcrop-Bereniceton	Stony sandy loam, moderately deep, well drained soils that developed on lava planes, wind worked material.	17	0.76	0.18	25.1	44.7
ID138	Malm-Matheson-Aecet	Fine sandy loam, deep to moderately deep, well drained soils, on lava planes	8.6	3.4	0.19	16.3	45.8
ID140	Whiteknob-Bereniceton-Medicine	Loam, very deep, well drained, formed in mixed alluvium and wind worked, basalt planes	2.9	10.54	0.21	11.7	59.3
ID161	Katseanes-Vadnais-Rock Outcrop	Silt loam, shallow, well drained soils that formed in loess influenced by valley side alluvium, on basalt planes and hills	18.5	0.46	0.28	21.8	43
ID162	Eaglecone-Vackton-Buist	Very stony loam to gravely loam, very deep, well drained, formed in loess and eolian deposits on basalt, on basalt planes	1.4	4.45	0.33	15.2	56.8
ID163	Fourme-Hagenbarth-Henryslake	Gravely loam, very deep, well drained, formed in alluvium derived from quartzite, limestone and sandstone	2.6	3.78	0.33	21.9	57.7
ID164	Judkins-Stringam-Targhee	Loam to extremely stony loam, moderately deep, well drained soils that formed in material weathered from rhyolite and closely related bedrock	13.5	1.64	0.32	23.3	49.3
ID165	Malm-Bondfarm-Aecet	Fine sandy loam, shallow to moderately deep, well drained soils formed from eolian deposits on lava planes	9.2	2.37	0.19	15.8	37.6
ID172	Parkalley-Latigo-Zeebar	Gravely loam to gravely silt loam, very deep, well drained soils formed from rhyolitic tuff and loess on mountain sides and foothills	25.8	4.61	0.36	18.8	61
ID178	Westindian-Shagel-Deadhorse	Silt loam to gravely silt loam, well drained, moderately deep from alluvium on mountains and foothills	15.3	5.58	0.28	11.5	50.5
ID184	Rock Outcrop-Rubble Land-Cryoborolls	Rocky, well drained, rubble land soils	52.1	6.68	0.07	9.2	54.3

(http://ortho.ftw.nrcs.usda.gov/cgi-bin/osd/osdname.cgi)

The summary of the STATSGO data found in Table 6 contains average soil slope, soil depth and the average K factor (Hoover 2000). These are weighted averages for the entire polygon of the MUID.

Soil permeability is a measure of the ease in which gases, liquids, or plant roots penetrate a layer of soil. Figure 13 depicts the soil permeability in inches per hour of soil units in the Beaver-Camas Subbasin. The least permeable soils are located in the 1) Thirteen Mile, Rattlesnake, and Corral Creek drainages, 2) in the headwaters of Stoddard and Pleasant Valley Creek drainages, on the eastern border of the watershed in MUID ID161 (0.46 in/hour), and 3) in the Mud Lake vicinity. The most permeable soils are located on the western edge, next to the Medicine Lodge Subbasin, having a permeability of 10.54 in/hour. Soil permeabilities in the remainder of the watershed are somewhere in between 2.7 and 6.68 in/hour.

Figures 14 and 15 show the hydrologic characteristics and soil drainage in the watershed. As expected, the most poorly drained soils in the subbasin occur in and around Mud Lake.

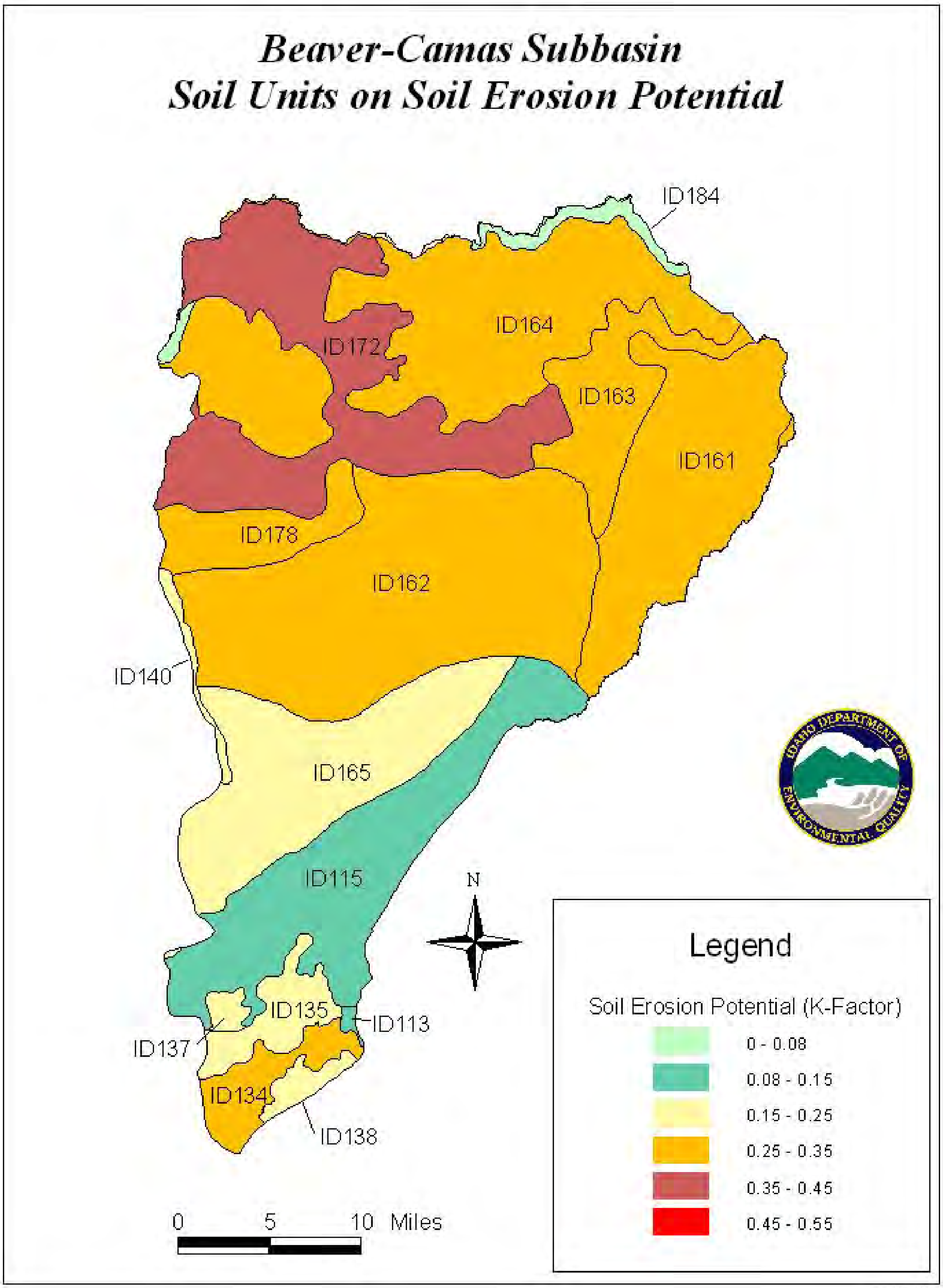


Figure 10. Soil Units on Soil Erosion Potential.

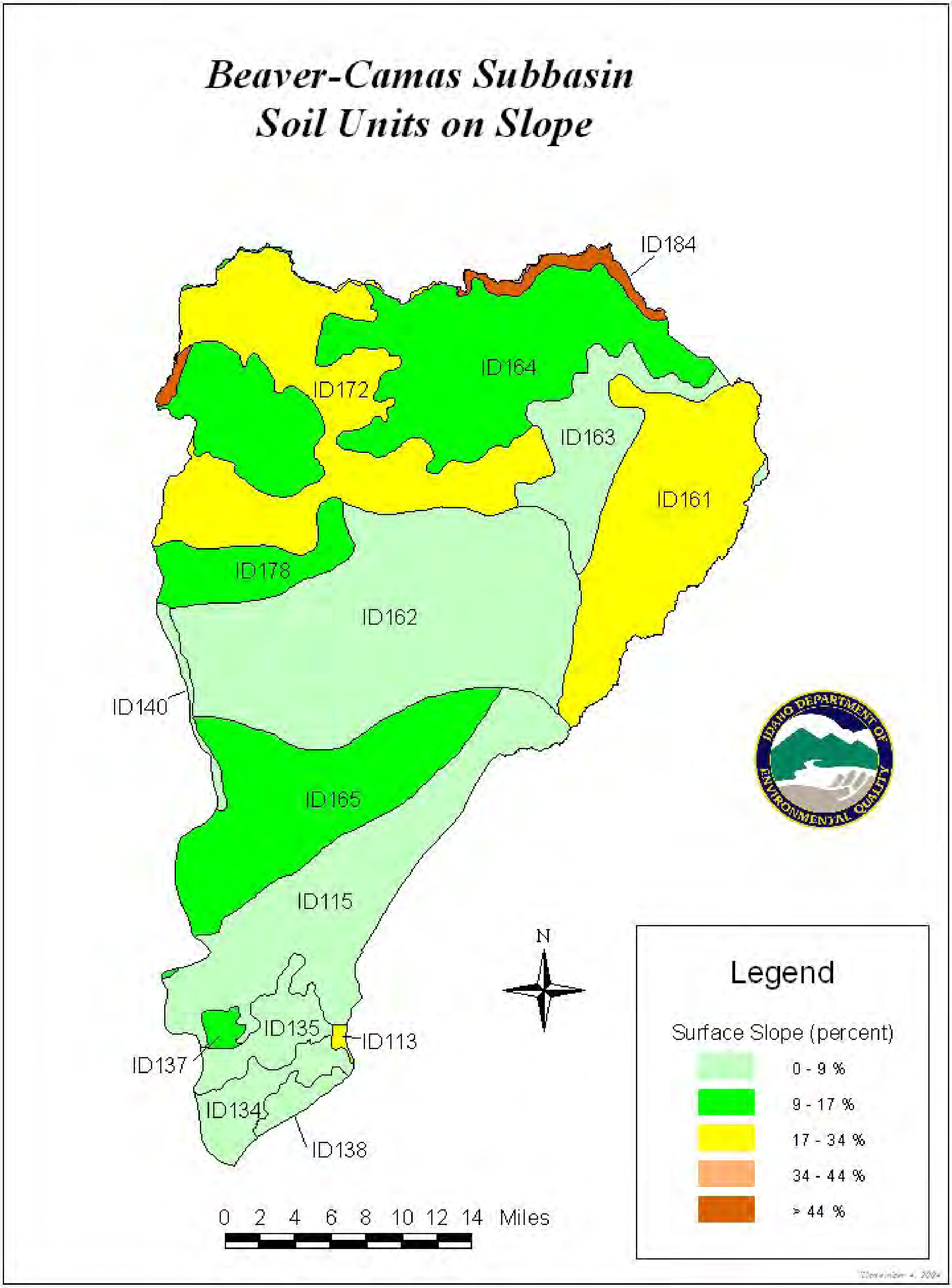


Figure 11. Soil Units on Slope.

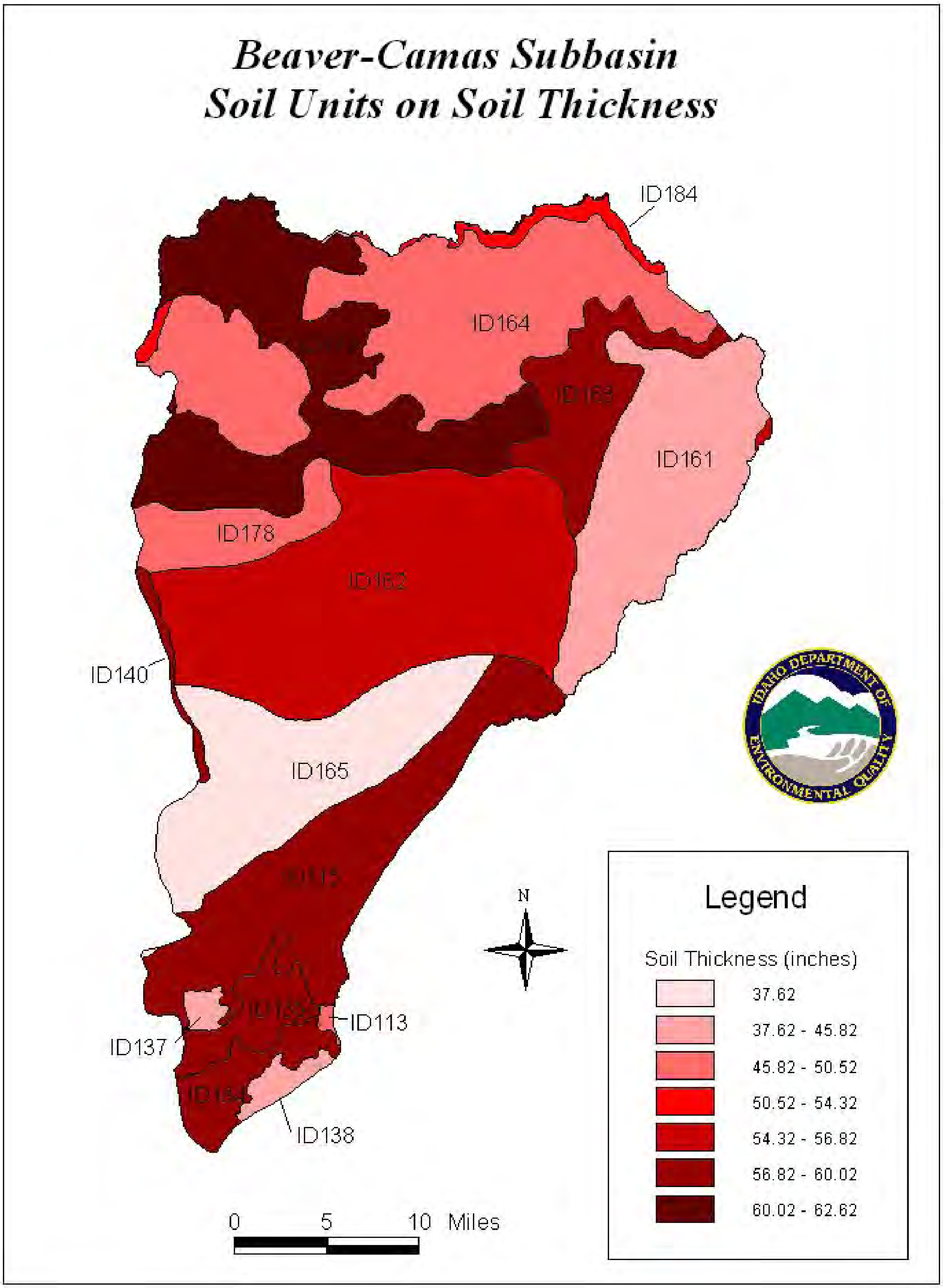


Figure 12. Soil Units on Soil Thickness.

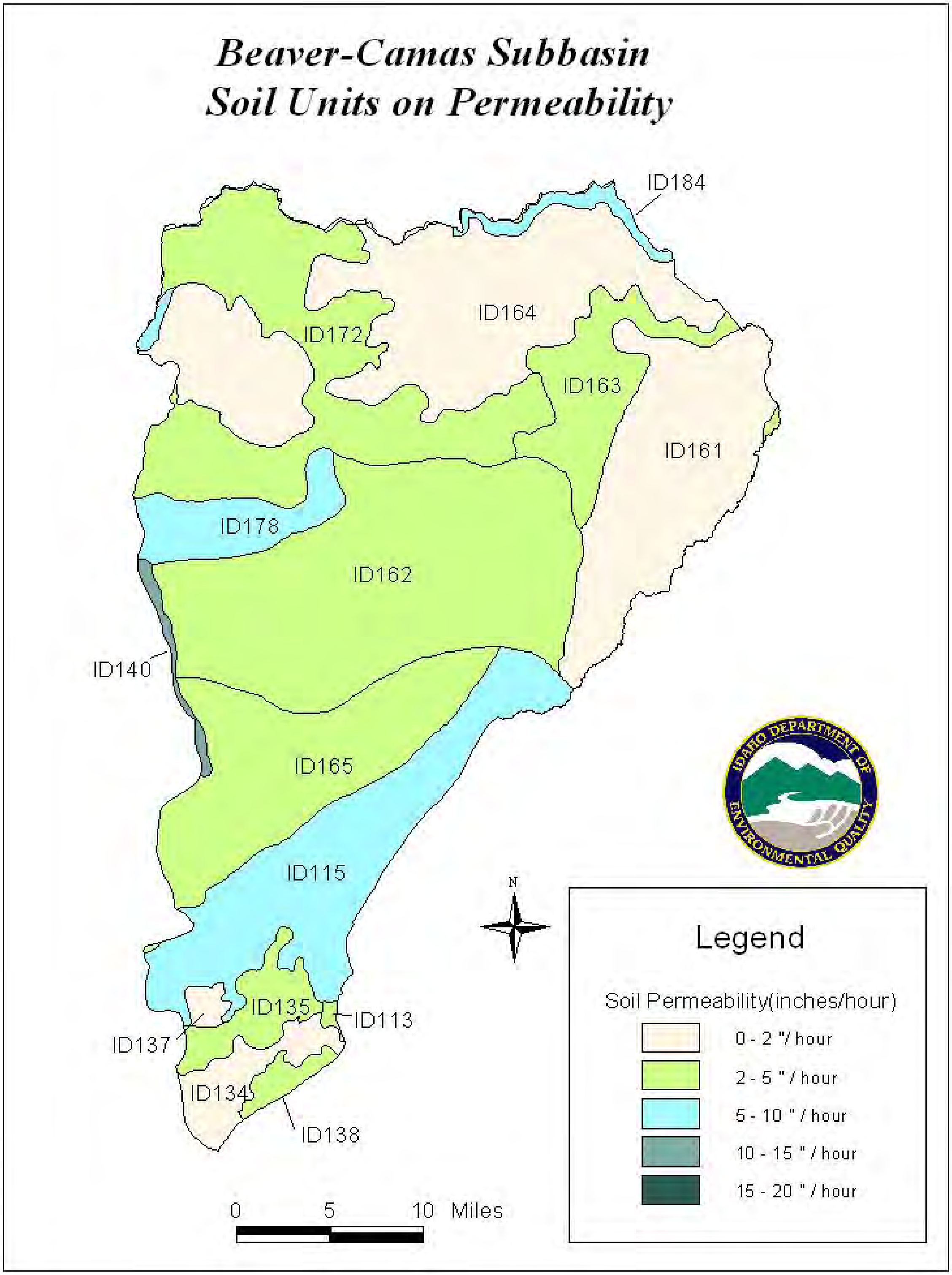


Figure 13. Soil Units on Soil Permeability.

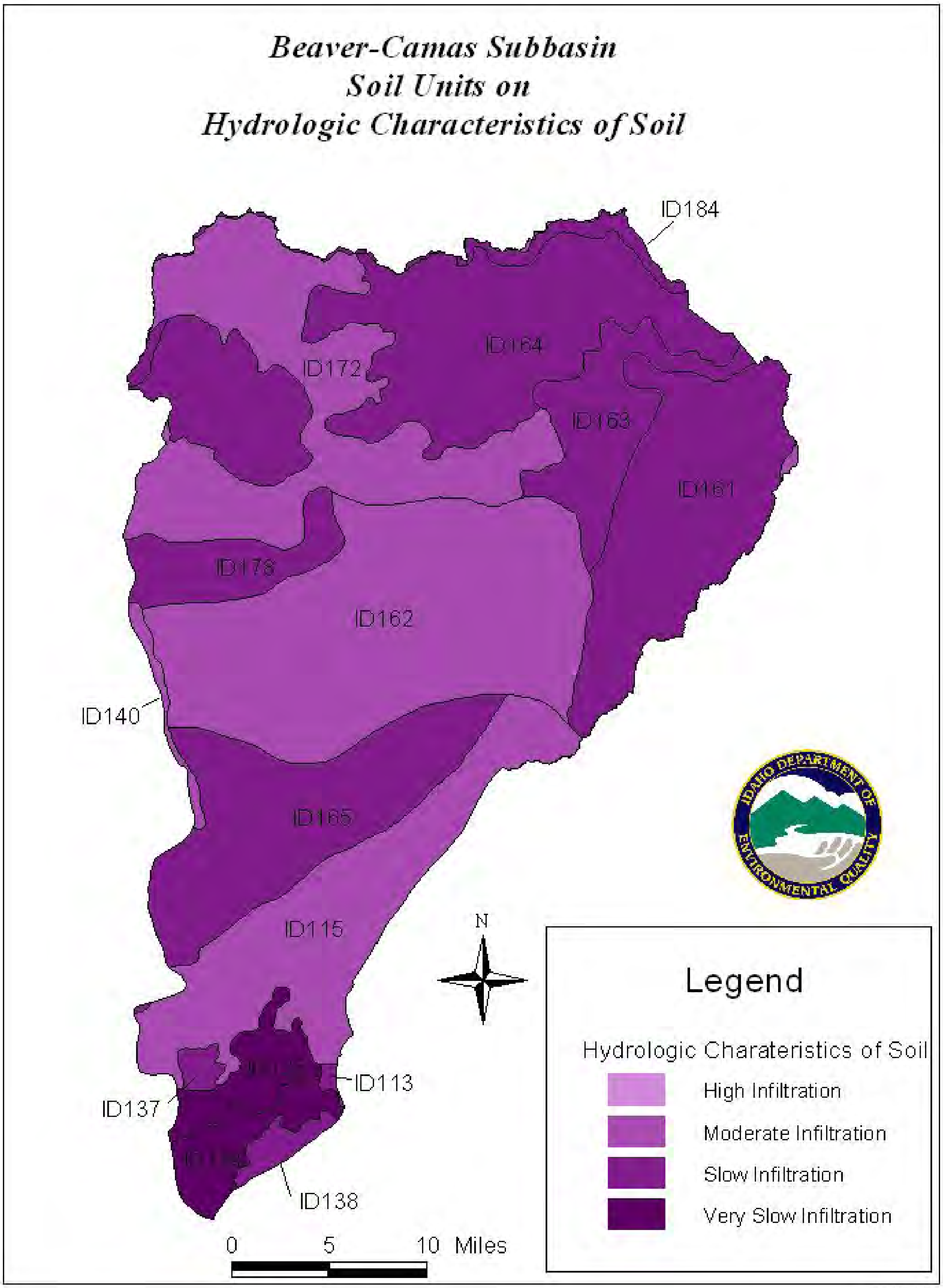


Figure 14. Soil Units on Hydrologic Characteristics of Soil.

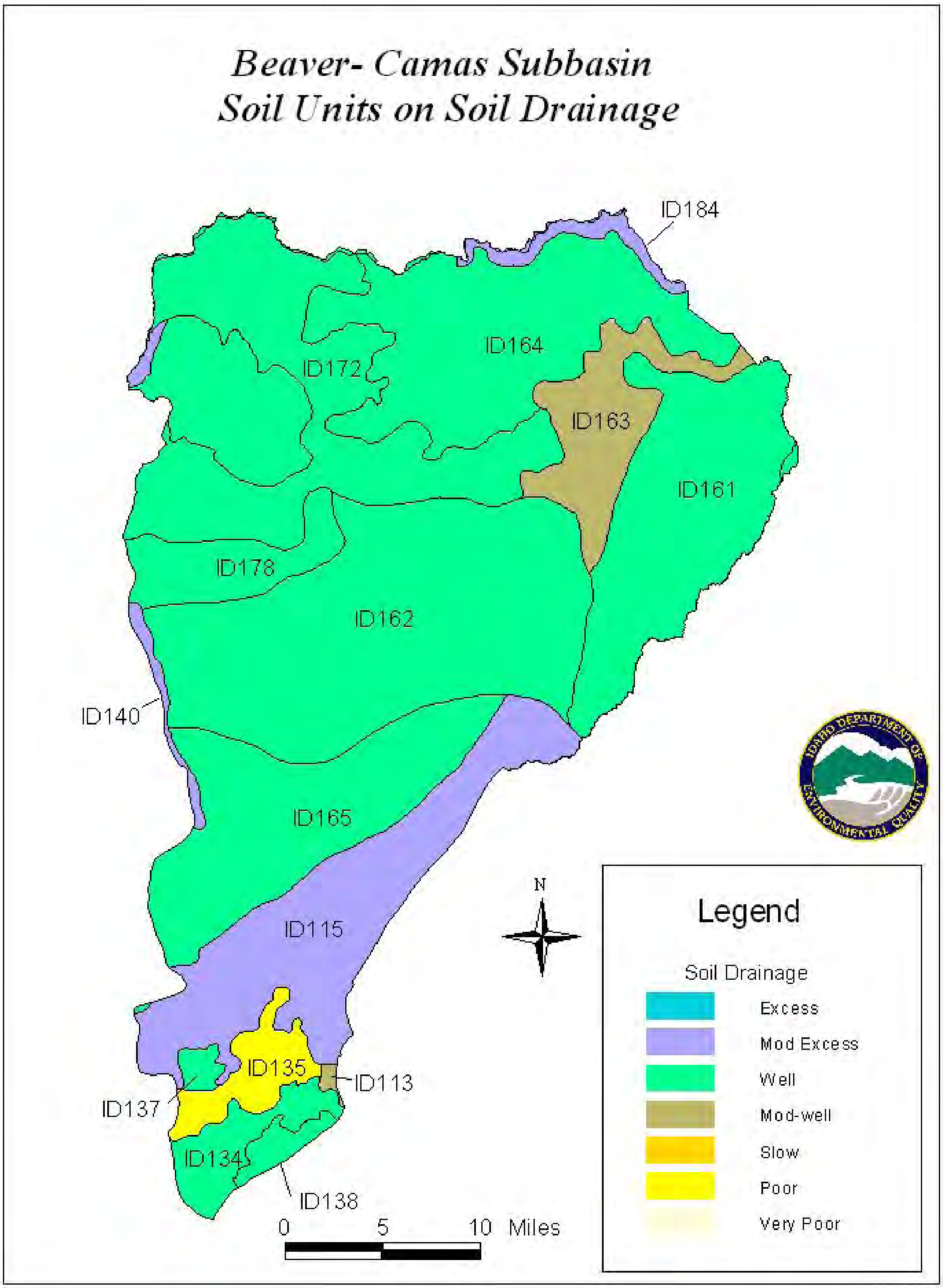


Figure 15. Soil Units on Soil Drainage.

Vegetation

Generally, overall vegetative cover in the watershed is that of rangeland vegetation, particularly in the central part of the watershed. The higher elevation, steeper sloped terrain in the basin is predominated by forestland. Irrigated crop production occurs in the southern portion of the watershed and pockets of dry land agriculture occur in the eastern portion of the subbasin. Windblown and lakebed deposits provide fertile agriculture land hence the incidence of crop production in this region of the subbasin. Figure 16 provides a description of landcover in the watershed.

Vegetation in the Beaver-Camas Watershed is very diverse, ranging from sagebrush and lava plants to lush wetlands and riparian corridors to forested mountains. This ecologically rich landscape of southeastern Idaho contributes to Idaho's biodiversity.

As a means for rare plant species conservation, the Bureau of Land Management (BLM) has created a *Rare Plant Field Guide* where plants listed in the guide are known or suspected to occur on lands administered by the BLM. Rare plants identified in the field guide as occurring in the Beaver-Camas Watershed are listed in Table 7.

Table 7. BLM identified rare plants in the Beaver-Camas Watershed.

Scientific Name	Common Name
Astragalus bisulcatus	Two-grooved milkvetch
Astragalus drummondi	Drummond's milkvetch

The Idaho Conservation Data Center (IDCDC), a division of NatureServe network, is a central repository for information Idaho's rare plant and animal species. The intent of IDCDC is to provide accurate, comprehensive, and timely information on Idaho's rare species so that appropriate land management decisions are made in the earliest stages of land management planning.

The IDCDC database is maintained and updated through ongoing biological analysis of rare, threatened, endangered, and special plant and animal communities. Data from those analyses are stored in the database and updated whenever additional information is available from agencies and institutions. (http://fishandgame.idaho.gov/tech/cdc/plants.home.cfm)

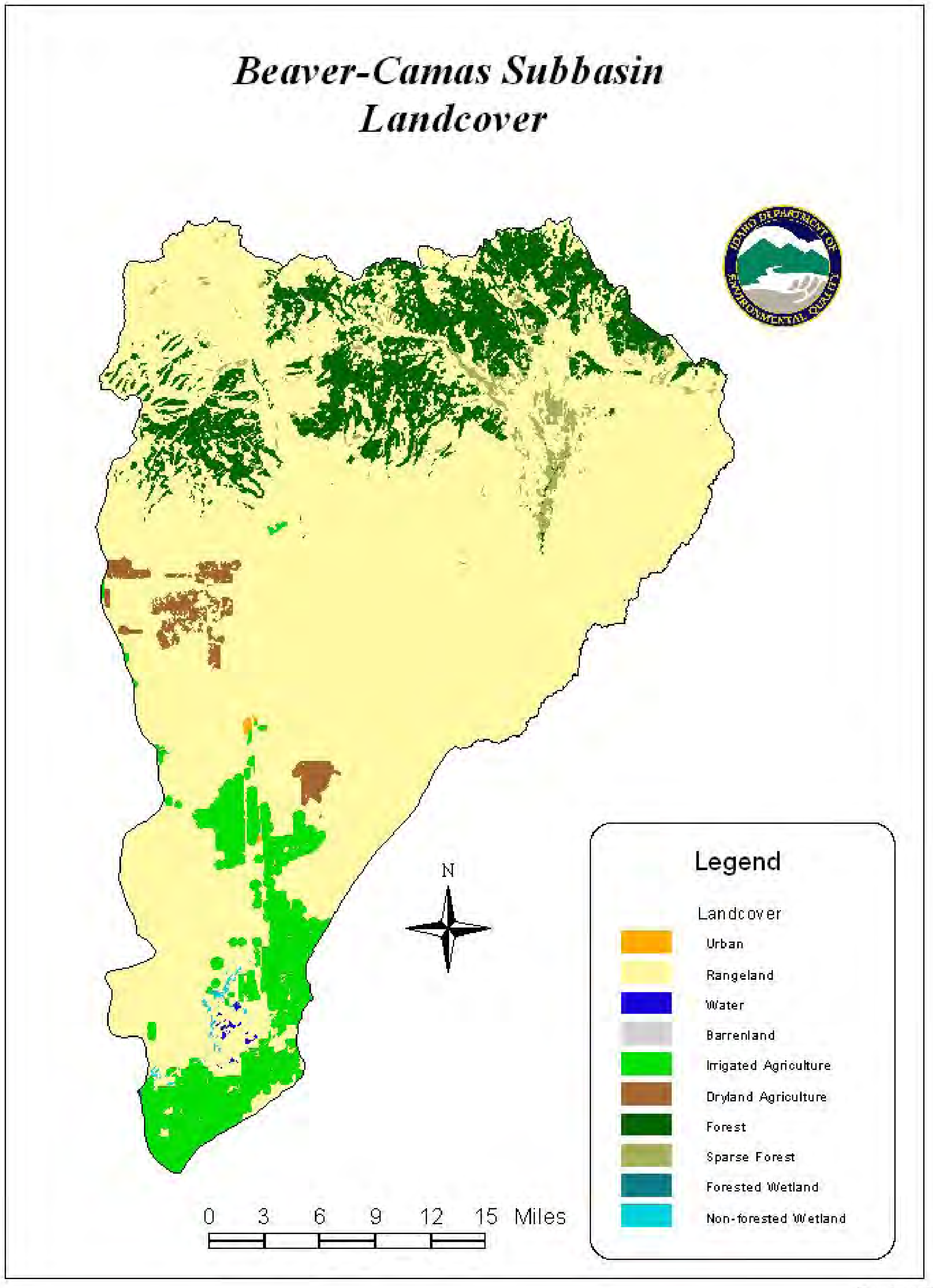


Figure 16. Beaver-Camas Subbasin Landcover.

A list of special status plants for Clark County, Idaho has been developed by the IDCDC. Identified special status plants are listed in Table 8 by scientific name (left column) and the associated common name (right column).

Table 8. CDC list of special status plants located in Clark County.

CLARK COUNTY	
AGOSERIS LACKSCHEWITZII	PINK AGOSERIS
ASTRAGALUS BISULCATUS VAR BISULCATUS	TWO-GROOVE MILKVETCH
ASTRAGALUS DIVERSIFOLIUS	MEADOW MILKVETCH
ASTRAGALUS DRUMMONDII	DRUMMOND'S MILKVETCH
ASTRAGALUS GILVIFLORUS	PLAINS MILKVETCH
BOUTELOUA GRACILIS	BLUE GRAMMA
CAMISSONIA PTEROSPERMA	WINGED-SEED EVENING PRIMROSE
CAREX PARRYANA SSP IDAHOA	IDAHO SEDGE
CHRYSOTHAMNUS PARRYI SSP MONTANUS	CENTENNIAL RABBITBRUSH
CUSCUTA DENTICULATA	SEPAL-TOOTH DODDER
DRABA INCERTA	YELLOWSTONE DRABA
EPILOBIUM PALUSTRE	SWAMP WILLOW-WEED
EPIPACTIS GIGANTEA	GIANT HELLEBORINE
KOBRESIA SIMPLICIUSCULA	SIMPLE KOBRESIA
LOMATOGONIUM ROTATUM	MARSH FELWORT
PIPTATHERUM MICRANTHUM	SMALL-FLOWERED RICEGRASS
PRIMULA ALCALINA	ALKALI PRIMROSE
SALIX CANDIDA	HOARY WILLOW
SALIX PSEUDOMONTICOLA	FALSE MOUNTAIN WILLOW
SCIRPUS ROLLANDII	ROLLAND BULRUSH
SILENE SCAPOSA VAR LOBATA	SCAPOSE SILENE
STIPA VIRIDULA	GREEN NEEDLEGRASS

Hydrography/Hydrology

Hydrologically, the Beaver-Camas Subbasin is a closed drainage, commonly referred to as a “sinks drainage.” The Beaver-Camas watershed is the easternmost drainage in a system that shows no connectivity to the Snake River. Surface water naturally infiltrates to the Snake River Plane Aquifer and a significant quantity of surface water is diverted for agricultural use.

Specifically, in the Beaver-Camas watershed, there are two main drainages that combine to form the subbasin: the Beaver Creek drainage and the Camas Creek drainage. Both of the drainages receive their flow in the northern mountainous regions in the upper watershed. Natural infiltration and irrigation limit the presence of water in the lower two-thirds of the subbasin.

The hydrology of the Beaver Creek drainage is principally spring runoff driven. There are several major tributaries that provide flow to Beaver Creek; Modoc Creek, Idaho Creek, Pleasant Valley Creek, Miners Creek, Stoddard Creek, and Dairy Creek. All of these waters drain into Beaver Creek above Spencer and they all are perennial streams. Few water diversions are above this point since the region is mountainous and unsuitable for crop production. Below Spencer, there are two main drainages, which are often intermittent, that flow to Beaver Creek. Those drainages are Rattlesnake Creek and Dry Creek. Water diversion structures are located in these two drainages, which contribute to reducing and/or eliminating perennial flow to Beaver Creek. Flow data from various USGS gauge stations (see section 2.3) provide a picture of the hydrologic characteristics in the Beaver Creek watershed. Water is sustained in Beaver Creek throughout the year in, above Spencer however, below Spencer, water naturally infiltrates into the porous basalt streambed and annual sustained flows are do not occur in Beaver Creek several miles downstream of Spencer.

The hydrologic characteristics of Camas Creek are even more complex and diverse that those of Beaver Creek. The upper eastern edge of the watershed is the source of flow to Camas Creek, like Beaver Creek, flows are principally spring runoff and precipitation driven.

From west to east, Crooked/Crab Creek, West Camas Creek, East Camas Creek, Warm Creek, Cottonwood Creek, Ching Creek, and Spring Creek all drain from the mountains, along the continental divide, to a complex of wetlands extending from Kilgore to Eighteenmile. There are several water diversion structures and canal systems utilized in this upper portion of the drainage with flows diverted for irrigated pastures in the valleys. Near Eighteenmile, below the wetlands, all of the streams converge to one point, this is considered the headwaters of Camas Creek. As shown by flow data in section 2.3, Camas Creek receives a very large volume of water from the upstream tributaries and flow is sustained in the creek year round to about T9N, R36E, Section 16 (N44.19270°, W-111.98284°), where land use changes from rangeland to irrigated agriculture and several major water diversion structures remove the surface water. The entire length of Camas Creek is a loosing reach through the porous basalt streambed.

Camas Creek, below Camas, will receive an annual spring flush, however continuous flows are not sustained above this point. Further downstream, just above the Camas Creek National Wildlife Headquarters, groundwater is pumped into a dry Camas Creek to return flows for irrigation. There is a complex system of groundwater wells that return flow to Camas Creek for irrigation. This system of wells, known as the "Owsley Wells," and the water pumped by them are responsible for providing the water that sustains Mud Lake.

Mud Lake is located in the southern tip of the Beaver-Camas Subbasin and it is the hydrologic endpoint. There are no natural surface flows from Mud Lake to any other body of water.

The Cottonwood Creek Complex is located on the very central western edge of the subbasin. This is a system of ephemeral streams that have no surface connectivity to other waters.

Section 2.3 provides a more detailed analysis of flow regimes in the Beaver-Camas Subbasin.

Fisheries

There are several species of fish residing in the Beaver-Camas Subbasin. Representatives of the sucker family (Catostomidae), sculpin family (Cottidae), sunfish family (centrarchidae), pike family (Esicudae), minnow family (Cyprinidae), as well as the trout and salmon family (salmonidae) are known to occur. The Utah sucker (*Catostomus ardens*) is the only member of the sucker family reported in the basin. Minnows reported in the subbasin include the longnose dace (*Rhinichthys cataractae*), speckled dace (*Rhinichthys osculus*), redside shiner (*Richardsonius balteatus*), and Utah chub (*Gila atraria*). Species of salmonidae reported in the subbasin include cutthroat trout (*Oncorhynchus clarki*), brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*) and rainbow x cutthroat hybrids. The largemouth bass (*Micropterus salmoides*), bluegill (*lepomis macrochirus*), and yellow perch (*Perca flavescens*) are members of the sunfish family and they are only located in Mud Lake at the base of the watershed. Like the members of the sunfish family, the tiger muskie (Esox lucius x Esox masquinongy), a member of the pike family has been introduced to Mud Lake for its fishery value. (Simpson and Wallace 1982, IDFG 1990)

The fishery in the Beaver-Camas Creek drainage, is dominated by brook trout, with limited trout survival below the Red Road on Camas Creek due to unfavorable water conditions. The Camas Creek stream is characterized by lava canyons with permeable streambeds and limited riparian vegetation for shading. Limited spawning habitat from irrigation withdrawals and over grazing in the lower sections of the watershed Creek limit trout survival and reproduction. (IDFG 1990)

The Yellowstone cutthroat trout (YCT) is the native species and the species of greatest concern in the subbasin. The historic range of the Yellowstone cutthroat trout includes the Yellowstone River drainage in Montana and Wyoming and portions of the Snake River Drainage in Wyoming, Idaho, Nevada, and Utah. It is thought that the Yellowstone cutthroat trout is currently located in approximately 10% of its original stream range. Several factors, such as habitat destruction, exploitation, and introductions of non-native fish have all contributed to the decline in YCT. (IDFG 2002)

The Yellowstone cutthroat is considered a state sensitive species in Idaho and is carefully managed by the Idaho Department of Fish and Game (IDFG). In 1998 it was petitioned to become a threatened species, but after review in February 2001, the USFWS declined the petition to list the Yellowstone cutthroat under the Endangered Species Act (ESA). In December 2004, a federal judge ruled that the USFWS illegally rejected the petition and subsequently ordered the USFWS to reconsider the request to grant federal ESA protection to the YCT.

Beaver

The beaver (*Castor canadensis*) is an important species in the development and continued sustenance of healthy stream and riparian systems. Beavers play an important role in maintaining stable channels by preserving riparian vegetation, reducing streambank erosion, storing sediment, raising the water table, and storing water for late season release. Beaver dams are typically constructed in willow dominated, medium to low gradient, meandering, valley bottom streams (Rosgen C or B type Channels). These channels evolved over time as beaver dams trapped fine sediments that were stabilized by willows. When vegetation and beaver are removed from the system (due to trapping and/or browsing competition) dams are no longer maintained and hence are more likely to fail and release stored sediment. The increase of upstream sediment supply from grazing, cultivated agriculture, roads, urban development and timber harvest can accelerate dam failure resulting in rapid sediment release. When changes occur in the riparian plant community, the positive benefits of beavers are lost and the stream is susceptible to incising and the productive riparian areas convert to drier upland sagebrush regions as a result of lowering the water table (Caribou-Targhee 2000).

Several streams in the Beaver-Camas Subbasin support active beaver complexes. Beaver dams have the potential to increase stream temperatures by reducing stream flows and holding water back in stagnant pools where thermal loading to the stream is higher.

Subwatershed Characteristics

The Beaver-Camas Subbasin is divided into six fifth field subwatersheds. The Upper Beaver Creek and Spring Creek subwatersheds have the highest drainage densities supplying the vast majority of surface water to the lower sections of the watershed. The Upper and Lower Beaver Creek subwatersheds contain the Beaver Creek drainage system. The Spring Creek, Camas Creek, and Camas Creek National Wildlife Refuge contain the Camas Creek drainage. The Cottonwood Creek subwatershed is entirely closed system of streams located on the western edge of the subbasin. Figure 17 provides an illustration of the subwatersheds in the subbasin.

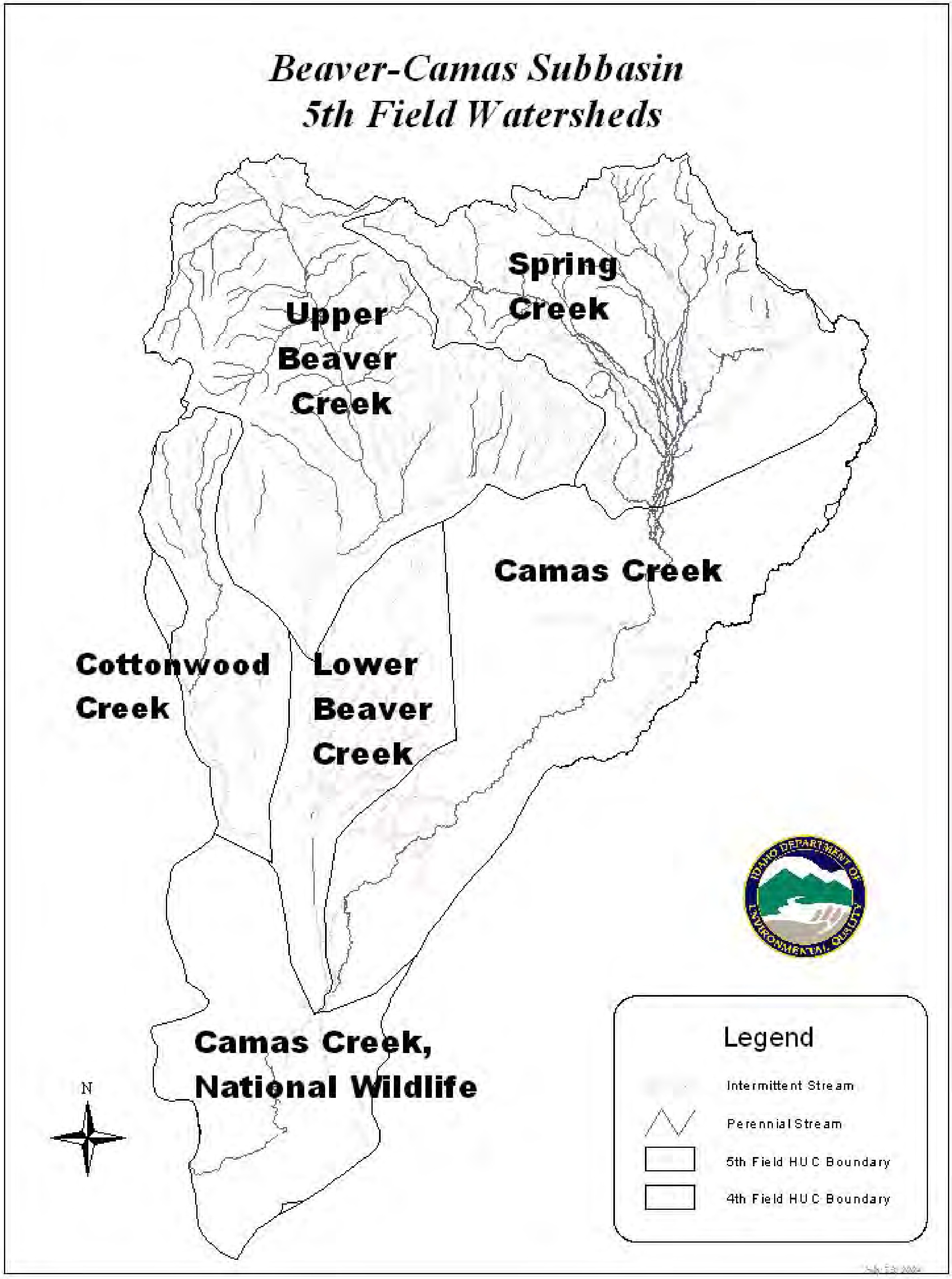
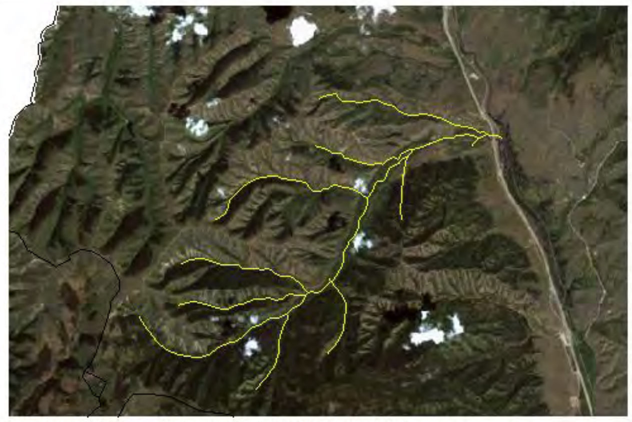


Figure 17. Beaver-Camas Subbasin Subwatershed Boundaries.

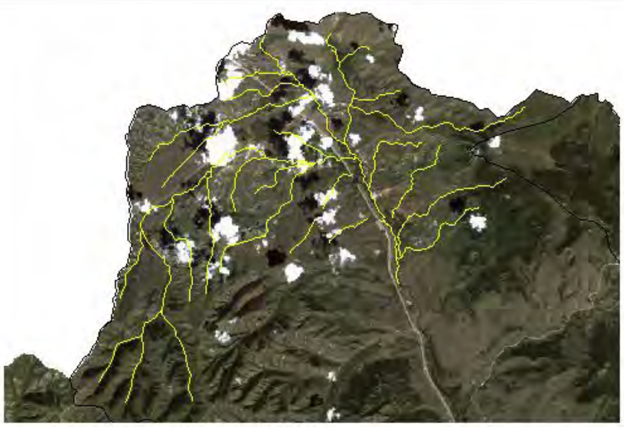
Upper Beaver Creek Subwatershed

The Beaver Creek subwatershed (158,056 acres) is positioned in the upper west half of the subbasin; the Continental Divide is the upper boundary. The lower subwatershed boundary is located below the Dry Creek confluence. All of the perennial streams in the Beaver Creek drainage are located in this subwatershed. Perennial streams in this watershed include Modoc Creek, Idaho Creek, Miners Creek, Pleasant Valley Creek, Dairy Creek, and Stoddard Creek. The Rattlesnake and Dry Creek drainages often do not show connectivity with Beaver Creek all year long. 303(d) listed (red line) portions of Beaver Creek are located in this watershed. Figure 18 provides a satellite image of the drainages in the Upper Beaver Creek subwatershed.

Idaho Creek ID17040205SK22
Source to mouth

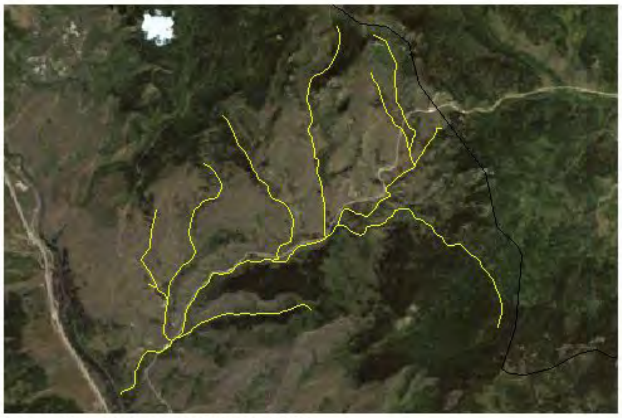


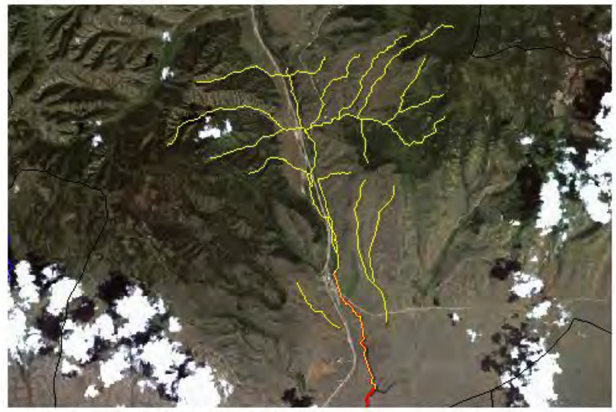
Pleasant Valley Creek ID17040205SK23
Source to Mouth

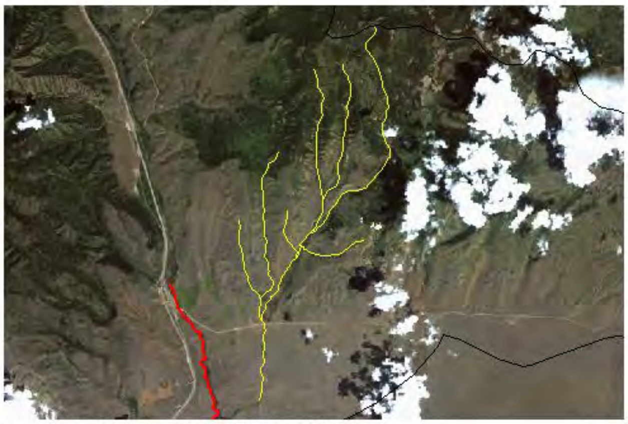


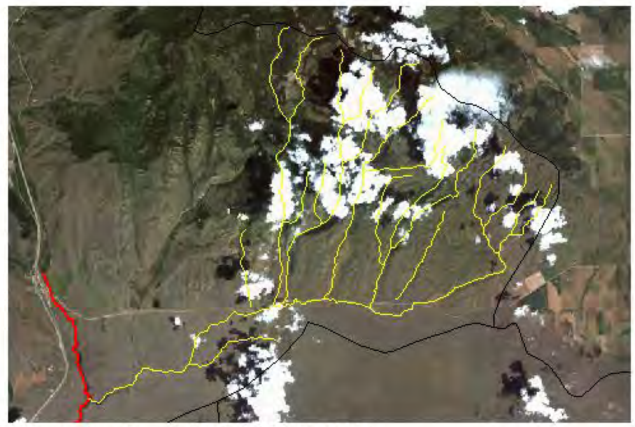
Beaver Creek ID17040205SK21
Source to Idaho Creek

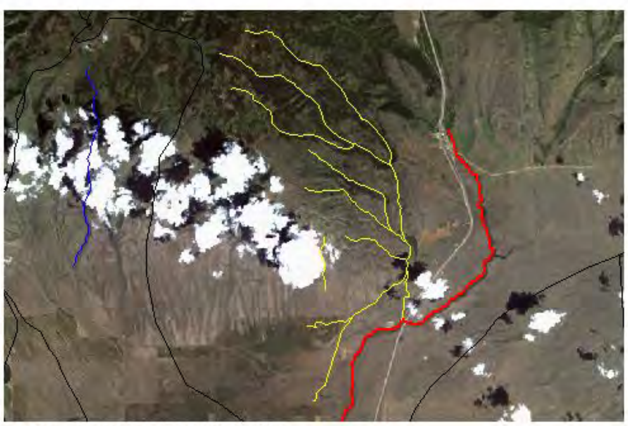
Beaver Creek ID17040205SK20
Idaho Creek to Miners Creek

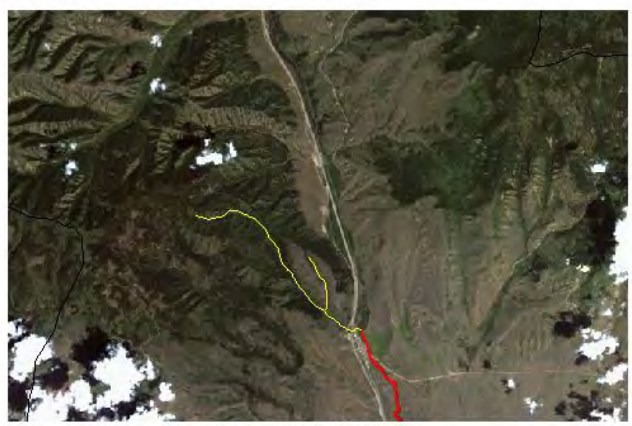

Miners Creek ID17040205SK19
Source to Mouth


Beaver Creek ID17040205SK18
Miners Creek to Rattlesnake Creek


Threemile Creek ID17040205SK17
Source to Mouth


Rattlesnake Creek ID17040205SK16
Source to Mouth


Dry Creek ID17040205SK25
Source to Mouth


Huntley Canyon Creek ID17040205SK24
Source to Mouth

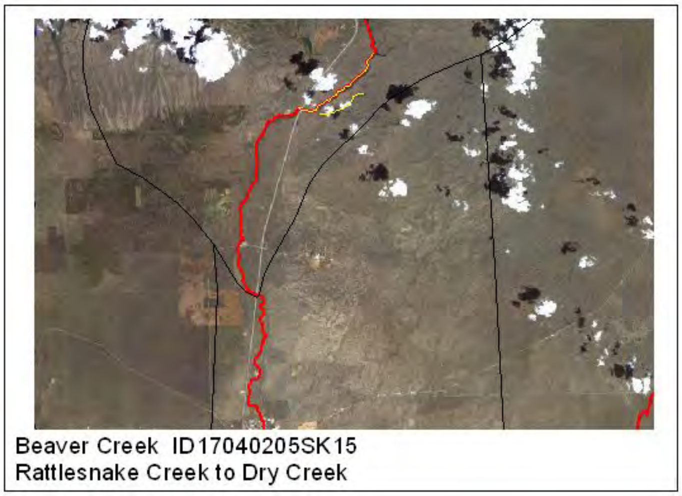
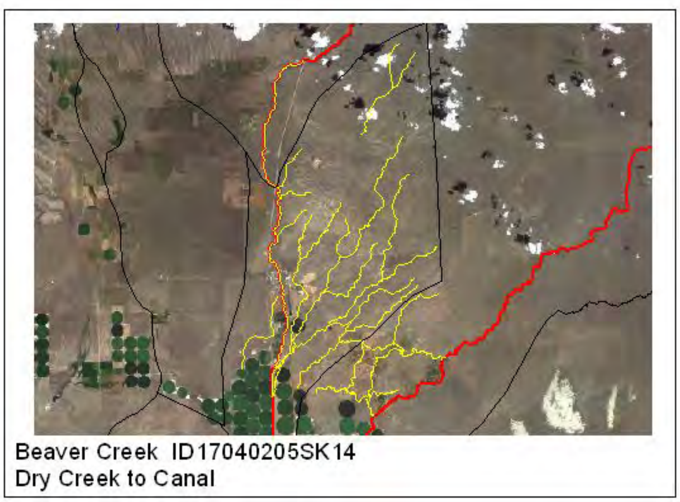


Figure 18. Drainages in the Upper Beaver Creek Subwatershed.

Lower Beaver Creek Subwatershed

The Lower Beaver Creek subwatershed (61,743 acres) is downstream of the Upper Beaver Creek subwatershed. It contains the section of Beaver Creek from the Dry Creek confluence to the mouth. The only tributaries feeding Beaver Creek are ephemeral and Beaver Creek is intermittent through this subwatershed. Approximately 3.5 miles south of Dubois, Beaver Creek is converted to a canal and all irrigated agriculture in this subwatershed is sustained by groundwater. This subwatershed contains some of the 303(d) listed (red line) portion of Beaver Creek.



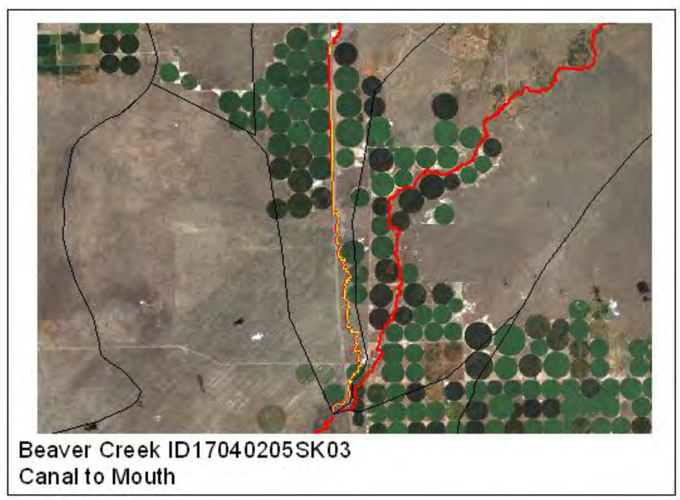
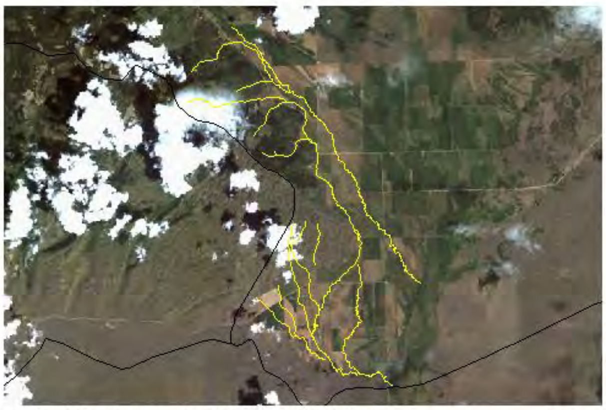


Figure 19. Drainages in the Lower Beaver Creek Subwatershed.

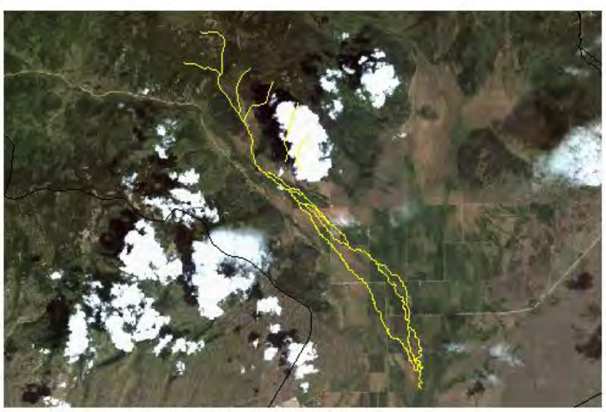
Spring Creek Subwatershed

This subwatershed is approximately 132, 958 acres and it is located in the northeastern section the subbasin. This Spring Creek subwatershed is bounded in the north by the Continental Divide with the lower end at the headwaters of Camas Creek near Eighteenmile. This subwatershed provides all of the drainage for Camas Creek. Perennial streams in this subwatershed are Crooked/Crab Creek, West Camas Creek, East Camas Creek, Warm Creek, Cottonwood Creek, Ching Creek, and Spring Creek. No 303(d) listed streams (red line) are located in this subwatershed.

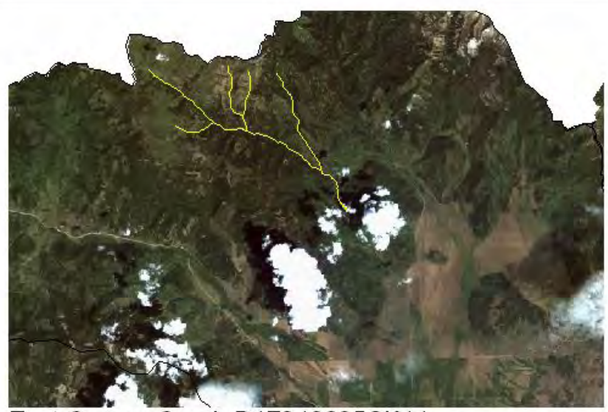


Crooked/Crab Creek D17040205SK08
Source to Mouth

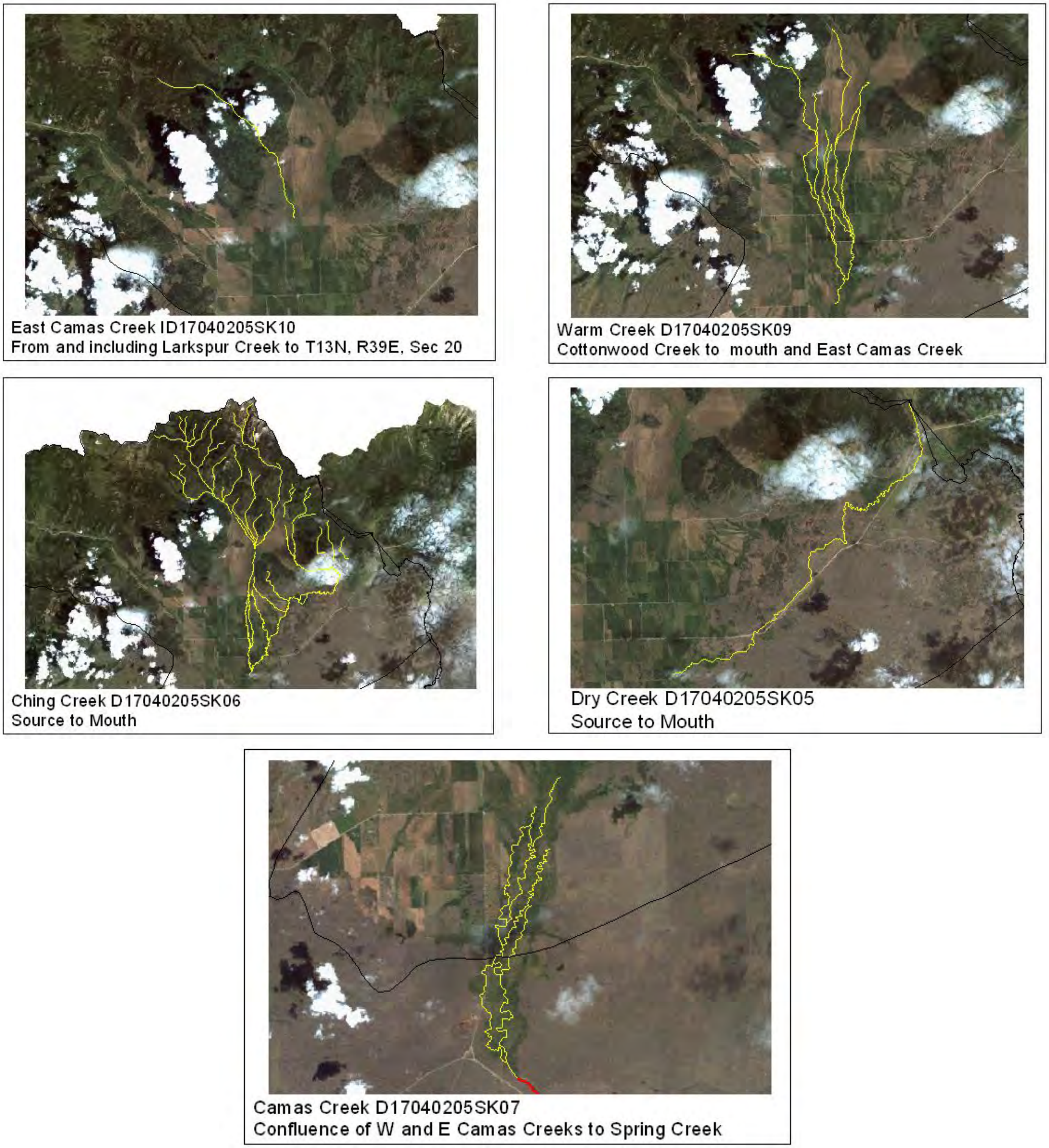
West Camas Creek ID17040205SK13
Source to Forest boundary



West Camas Creek ID17040205SK12
Forest boundary to Camas Creek



East Camas Creek D17040205SK11
Source to Larkspur Creek



East Camas Creek ID17040205SK10
From and including Larkspur Creek to T13N, R39E, Sec 20

Warm Creek D17040205SK09
Cottonwood Creek to mouth and East Camas Creek

Ching Creek D17040205SK06
Source to Mouth

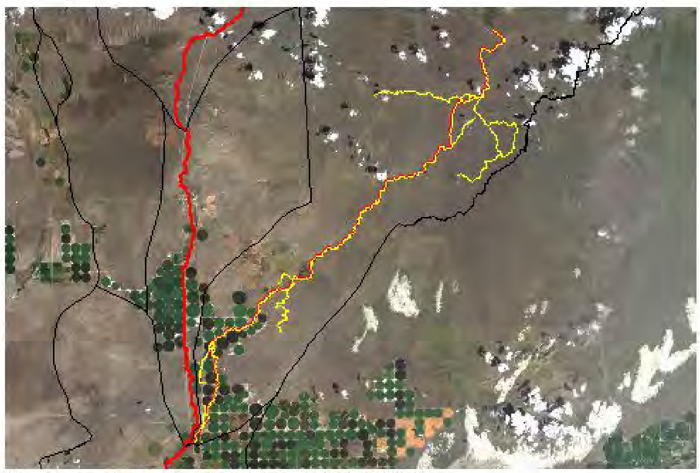
Dry Creek D17040205SK05
Source to Mouth

Camas Creek D17040205SK07
Confluence of W and E Camas Creeks to Spring Creek

Figure 20. Drainages in the Spring Creek Subwatershed.

Camas Creek Subwatershed

This subwatershed (15,5471 acres) is located below the Spring Creek subwatershed and drains to the confluence of Beaver Creek. Camas Creek is the only water in this subwatershed and this section of Camas Creek is 303(d) listed (red line) for flow alteration, habitat alteration, sediment, nutrients, and temperature. Irrigation systems are placed all along Camas Creek from Spring Creek to Beaver Creek. Irrigation removal and natural infiltration limit perennial surface water flows in the lower section of this subwatershed . As depicted in Figure 21, in the lower section of this particular reach, the land use changes from rangeland to irrigated farmland.



Camas Creek D17040205SK02
Spring Creek to Beaver Creek

Figure 21. Camas Creek Subwatershed.

Camas Creek National Refuge Subwatershed

This subwatershed (81,206 acres) is bounded by the Beaver Creek confluence to Mud Lake, and contains the Camas Creek National Refuge. Camas Creek is naturally devoid of flow through the entire subwatershed, however, a complex irrigation system where groundwater is pumped into Camas Creek supplies irrigated agriculture in the area. Groundwater flow for irrigation eventually reaches Mud Lake, which is the endpoint for all drainage in the subbasin.

The section of Camas Creek in this watershed is 303(d) listed for flow alteration, sediment, and nutrients.

<u>Camas National Wildlife Refuge</u>

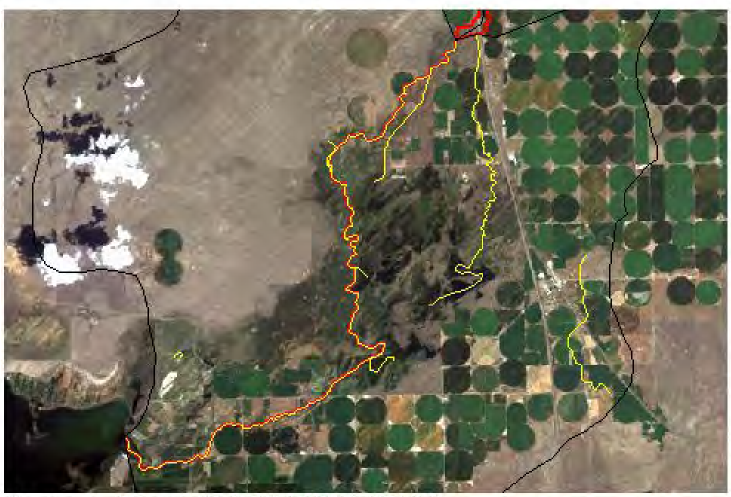
The Camas National Wildlife Refuge was established in 1937, with the intent to provide habitat for nesting waterfowl and to provide resting and feeding habitat for spring and fall migrating ducks, geese, and other waterfowl. The wildlife refuge is located in the Beaver-Camas Subbasin, 36 miles north of Idaho Falls at an elevation of about 4800 feet.

Camas Creek flows for eight miles through the length of the refuge and provides water to the many lakes and ponds located within the refuge boundaries. During the dry summer months, several wells sustain the lakes and ponds continuing to provide suitable habitat year round.

Mud Lake

Mud Lake, authorized by the Flood Control Act of 1950, was formed by a 10-mile-long embankment constructed years ago by local farmers. The embankment confines the lake and makes it possible to farm the surrounding lands and provide water elevation so that irrigation canals could deliver water to farms.

Mud Lake is a designated state Wildlife Management Area (WMA), established primarily to preserve and improve nesting habitat for waterfowl. The lake also provides a recreational fishery.



Camas Creek D17040205SK01
Beaver Creek to Mud Lake

Figure 22. Camas Creek National Refuge Subwatershed.

Cottonwood Creek

The Cottonwood Creek subwatershed (49,184 acres) is located on the western edge of the subbasin. This subwatershed contains several ephemeral streams: Cow Creek, Patelzick Creek, and the Cotton Wood Creek complex. This system is entirely closed, showing no connectivity to other surface waters. Cow Creek is the listed stream in this subwatershed.

Figure 23. Cottonwood Creek Subwatershed.

Stream Characteristics

Geomorphic characteristics of the streams in the Beaver Creek Subbasin vary considerably. Appendix A contains a summary of the subbasin's stream characteristics collected by the DEQ Beneficial Use Reconnaissance Program (BURP). These data provide a detailed description of several stream characteristics.

Geomorphic characterization of the steam channels was achieved utilizing the Rosgen Stream Classification System, Level 1 for stream types. Rosgen type A streams are entrenched, high energy, steep gradient streams with cascades and step/pool morphology. Rosgen type B streams are moderate gradient, with riffles. Rosgen type C streams are low gradient, slightly entrenched, meandering streams with point bar development, riffle/pool morphology and a well-defined floodplain. Rosgen type D streams occur in broad valleys and are braided streams with point bar formations. Rosgen E type streams are very low gradient, found in broad valleys, and highly sinuous. Rosgen F type streams are low gradient, entrenched meandering streams with riffle/pool formations. Rosgen G type streams are moderate gradient, entrenched streams with step/pool morphology. (Rosgen 1996)

Stream order is a hierarchical system for categorizing streams based on their degree of branching. For example, a first order stream is unbranched, a second order stream is a combination of two first order streams and, two second order streams make a third order stream, etc. Stream order is determined using a 1:100,000-scale map.

Substrate measurements are collected via a modified Wolman Pebble Count. The width/depth ratio is the ratio of the bankfull surface to the average depth of the bankfull channel. This measurement is essential to comprehending the distribution of available energy within a channel and the capability of discharges within the channel to transport sediment. Width/depth ratios are beneficial in determining channel stability. Sinuosity is "the ratio of channel length between two points in a channel to the strait line distance between the same two points".

Figures 24-29 show the stream and BURP site locations by subwatershed.

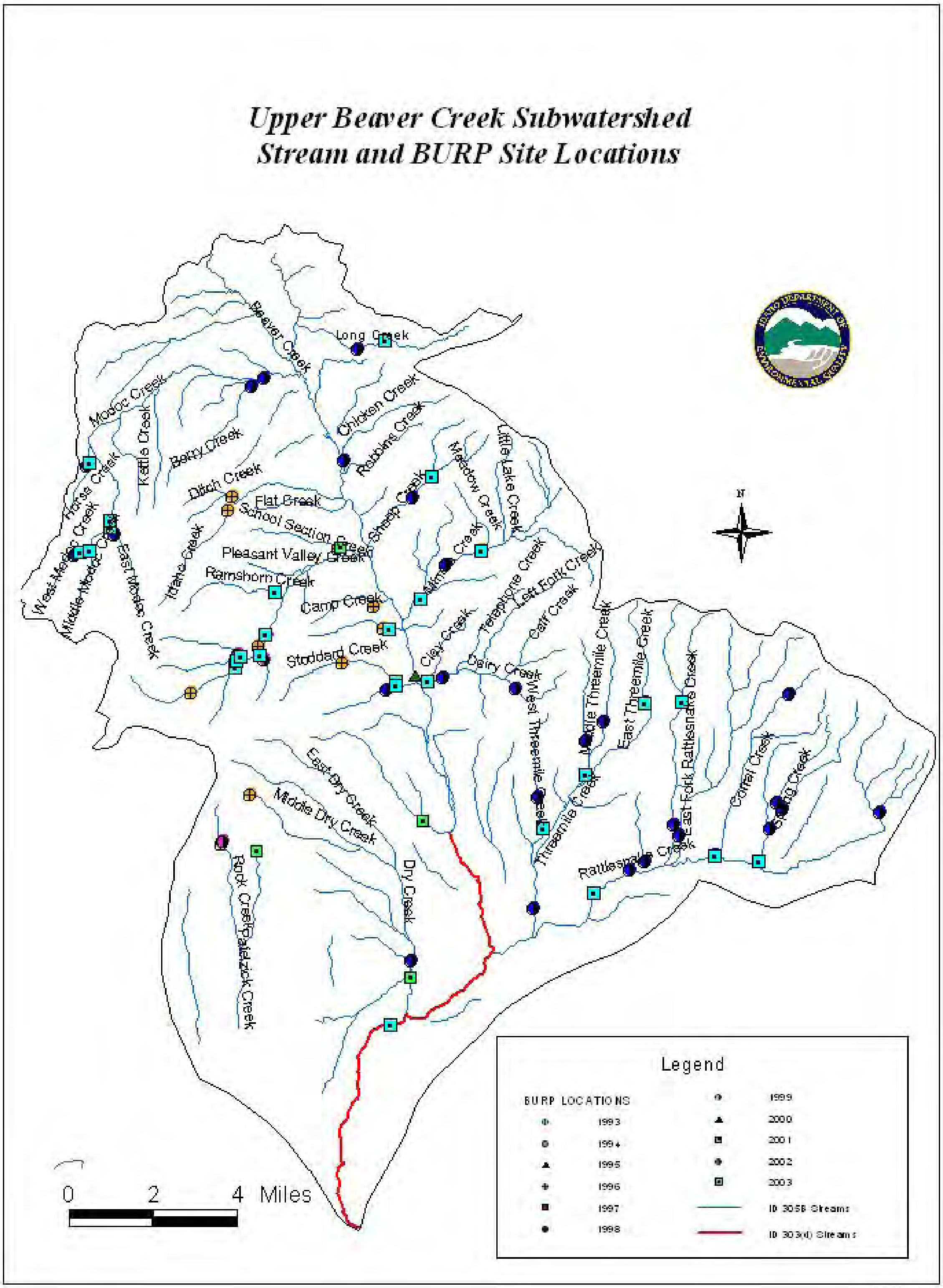


Figure 24. Stream and BURP Site Locations in the Upper Beaver Creek Subwatershed.

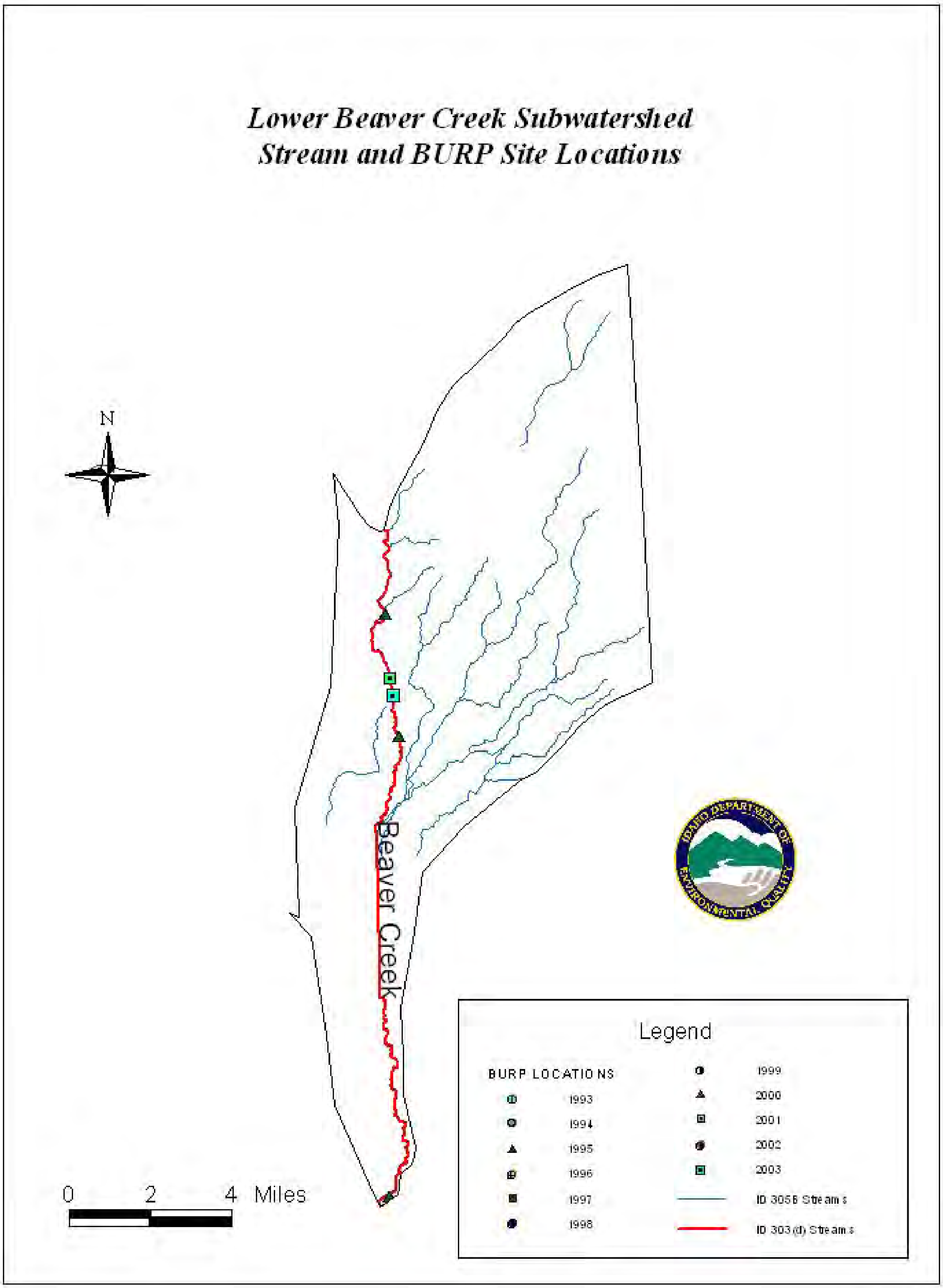


Figure 25. Stream and BURP Site Locations in the Lower Beaver Creek Subwatershed.

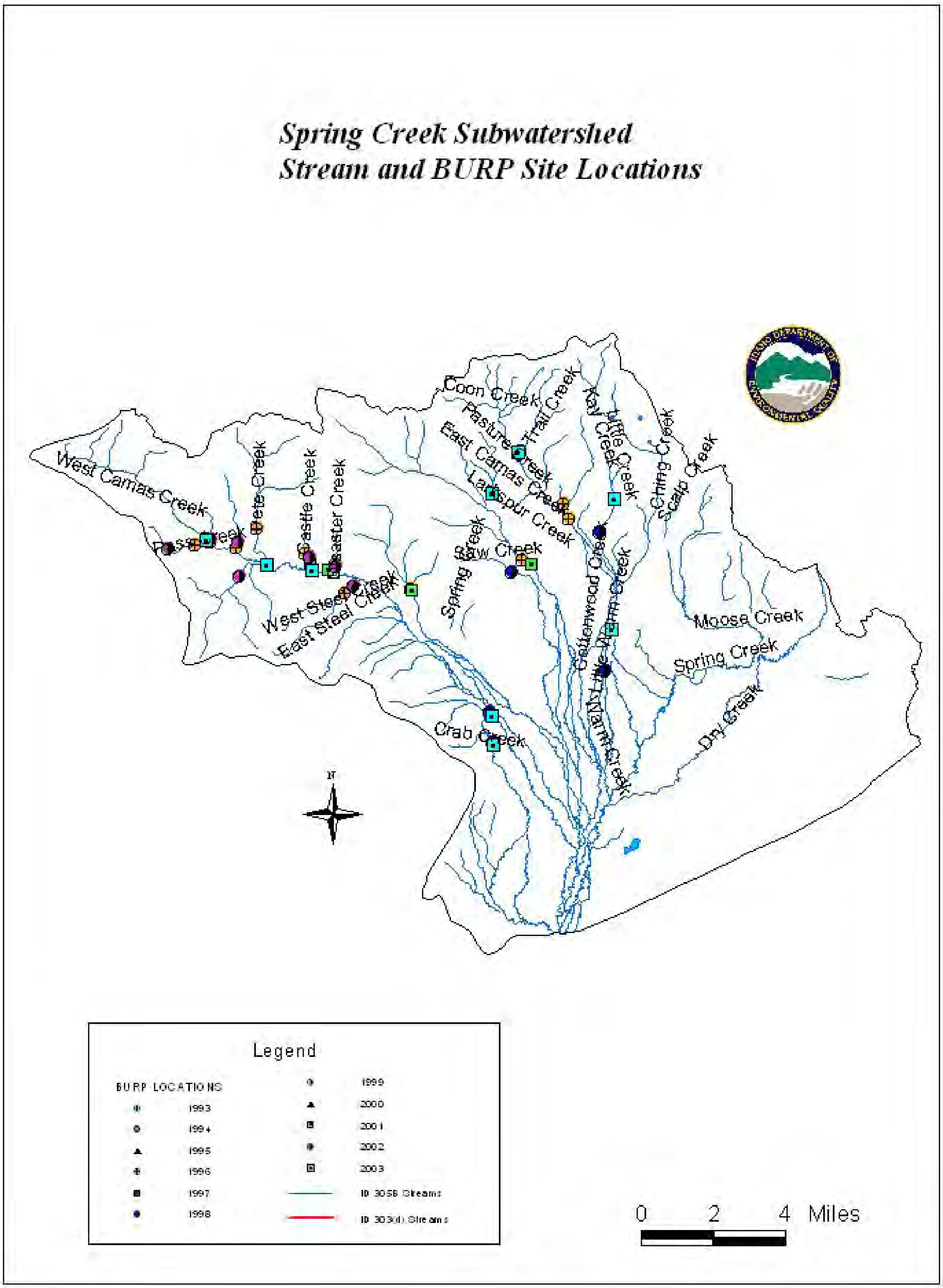


Figure 26. Stream and BURP Site Locations in the Spring Creek Subwatershed.

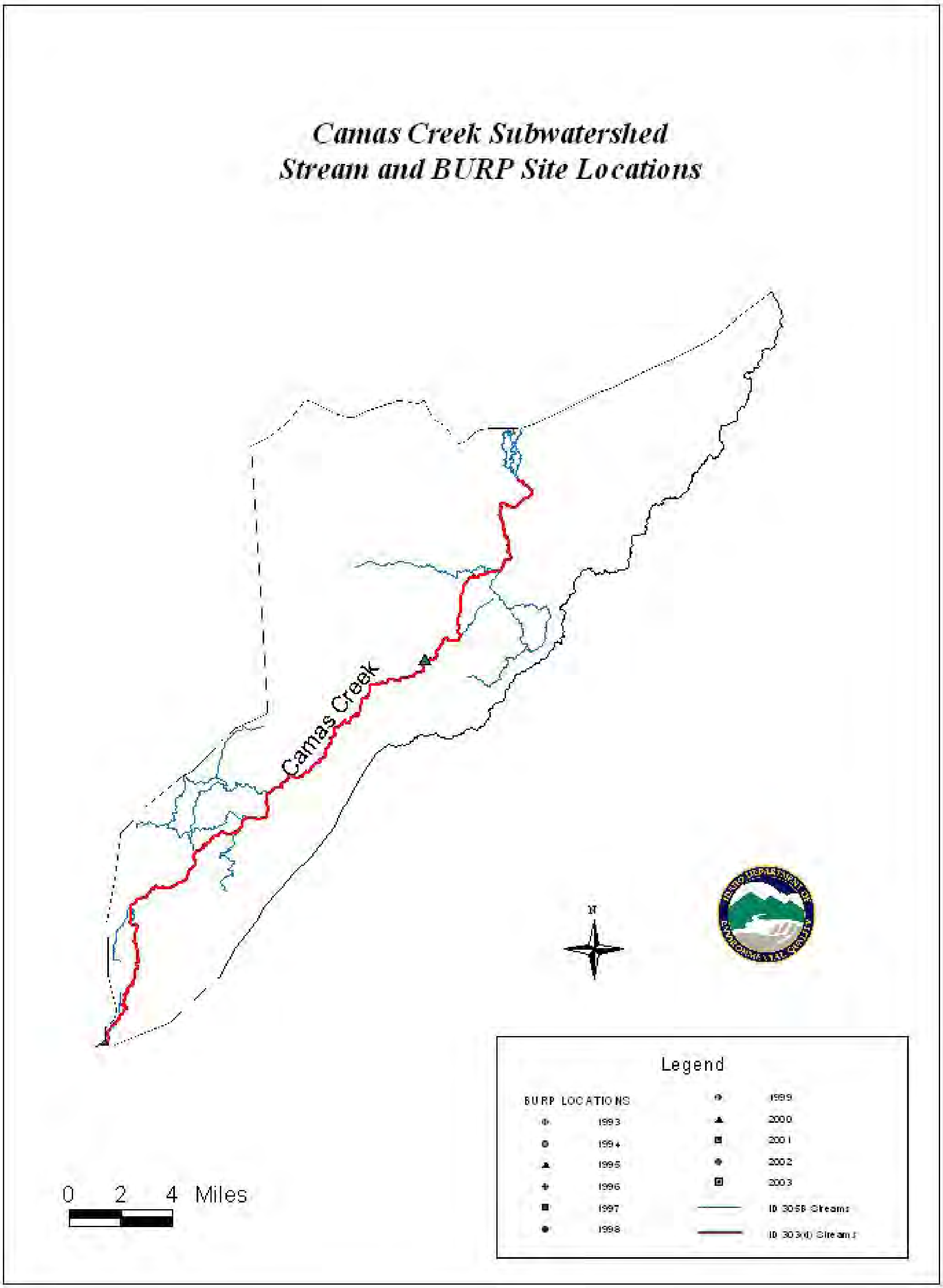


Figure 27. Stream and BURP Site Locations in the Camas Creek Subwatershed.

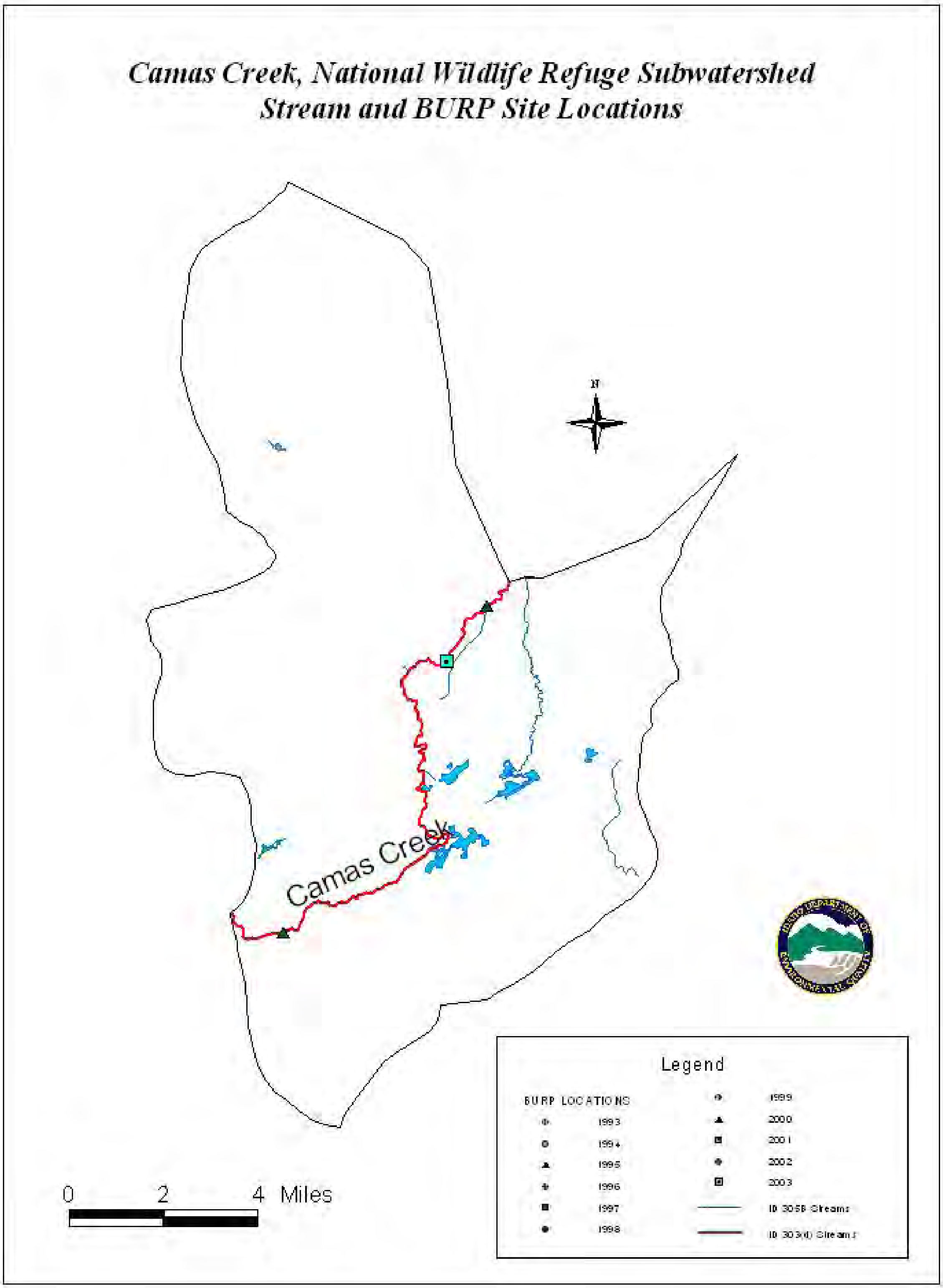


Figure 28. Stream and BURP Site Locations in the Camas Creek, National Wildlife Subwatershed.

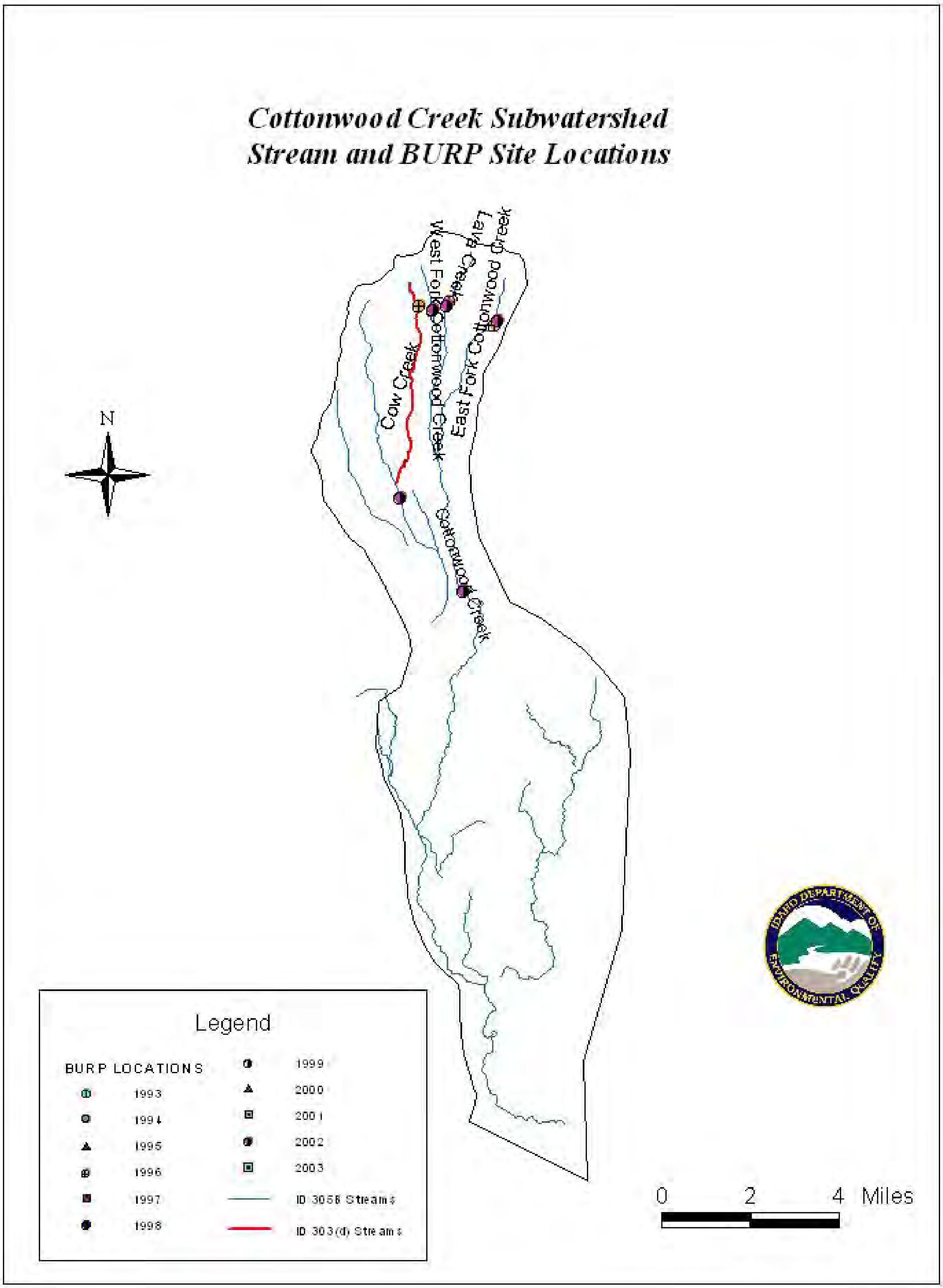


Figure 29. Stream and BURP Site Locations in the Cottonwood Creek Subwatershed.

1.3 Cultural Characteristics

The Beaver-Camas subbasin is a sparsely populated area with very few commercial activities. The main source of income in the area is agricultural related; the higher elevation regions of the watershed are reserved for rangeland and the lower sections of the watershed are utilized for irrigated crop production.

Landuse

Land use in the subbasin is primarily agriculture (Table 9 and Figure 30), with the majority of the watershed utilized for rangeland (64%). Forest lands are located in the northern, high elevation, steep terrained areas of the subbasin, approximately 21% of total land use.

The majority of the irrigated land (gravity flow and sprinkler) is located in the southern portion of the watershed where soils and topography are more amenable to crop production. A rich riparian community exists around Mud Lake; this is the smallest portion of land use at 1%.

Table 9. Land use statistics for the Beaver-Camas Subbasin.

Land use	Acres	% of Total
Forest	136059	21%
Rangeland	411842	64%
Irrigated-Sprinkler	38950	6%
Irrigated-Gravity Flow	48388	8%
Riparian	7849	1%
Total	**643088**	**100%**

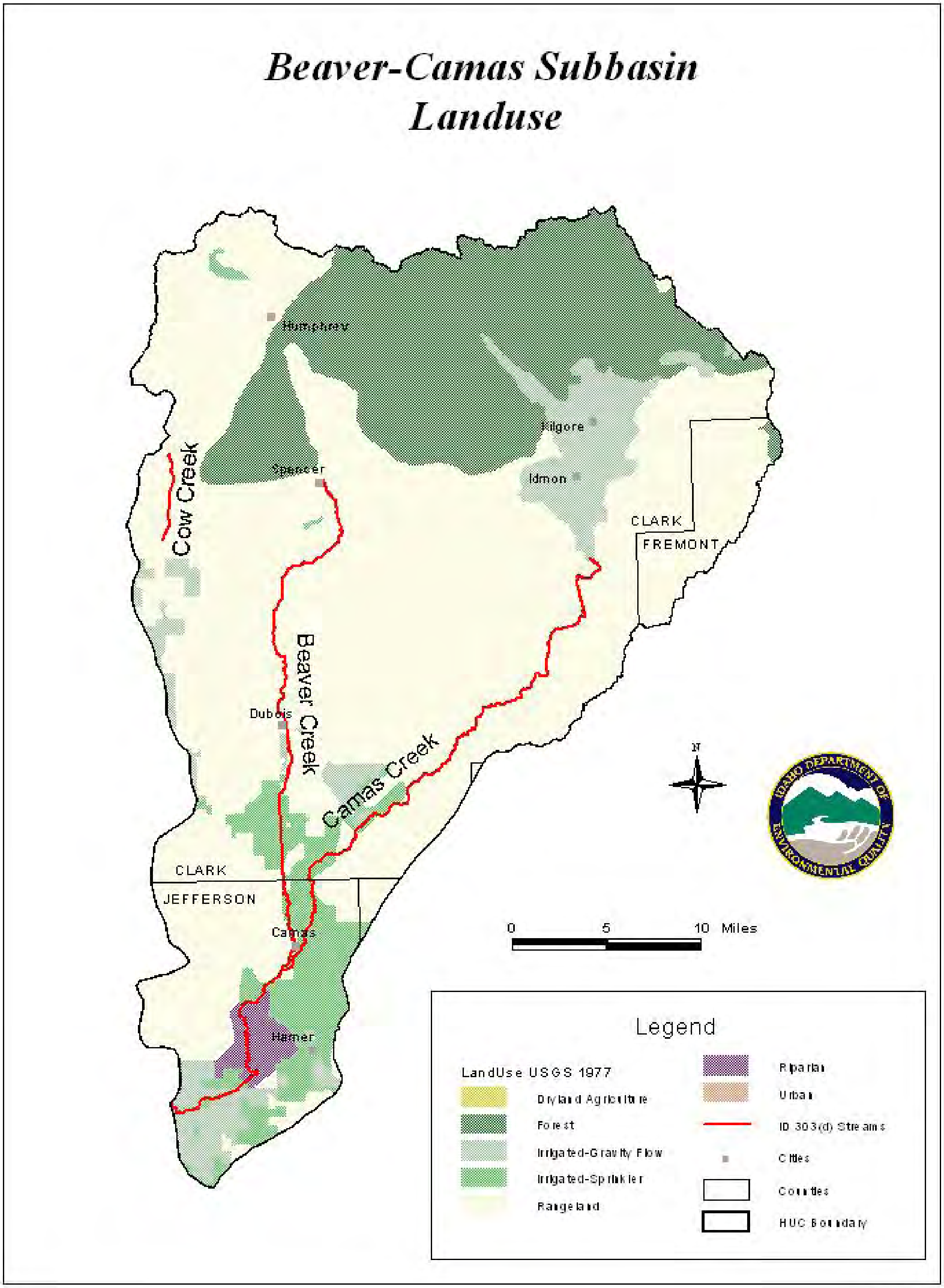


Figure 30. Land Use in the Beaver-Camas Subbasin.

Land Ownership, Cultural Features, and Population

The majority (61%) of landownership in the Beaver-Camas Subbasin is public (Table 10 and Figure 31). The Caribou-Targhee Forest Service manages the high elevation mountainous regions, constituting 28% of the subbasin. Some of this 28% delineated in Figure 31 is a continuous patch of land just north of Dubois. This portion of land, in a low gradient, basalt plane portion of the watershed is the United States Department of Agriculture (USDA) Sheep Experiment Station. Outside of the USFS property, the rest of the subbasin's landownership is a mosaic of private, BLM, and state. The USFWS owns and manages 2% of the land in the subbasin, with the Camas National Wildlife Refuge.

Table 10. Landownership statistics for the Beaver-Camas Subbasin.

Owner	Acres	% of Total
Private	248214	39%
BLM	130975	20%
State of Idaho	74254	12%
US Fish and Wildlife Service	10542	2%
US Forest Service	178592	28%
Water	466	0%
Total	**643043**	**100%**

The Beaver-Camas Subbasin is rural, with very small towns located in Jefferson and Clark Counties (Figure 31). The largest town is Dubois with a 2002 population of 690. The two remaining towns with population data are Hamer and Spencer with populations of 12 and 37, respectively. Figure 31 shows the county boundaries and town locations in the subbasin.

There are no NPDES permitted facilities located in the subbasin, however, there are several Waste Water Land Application (WWLAPP) sites for the treatment of waste water (figure 31). All of the WWLAPP sites, with the exception of one, are owned and operated by a commercial farm for the treatment of potato process water. The commercial sites total 1853 acres, with the majority of the land treatment occurring in southern Clark County. A very small site (49 acres) is located in Dubois, serving as the City of Dubois's facility for treating wastewater effluent.

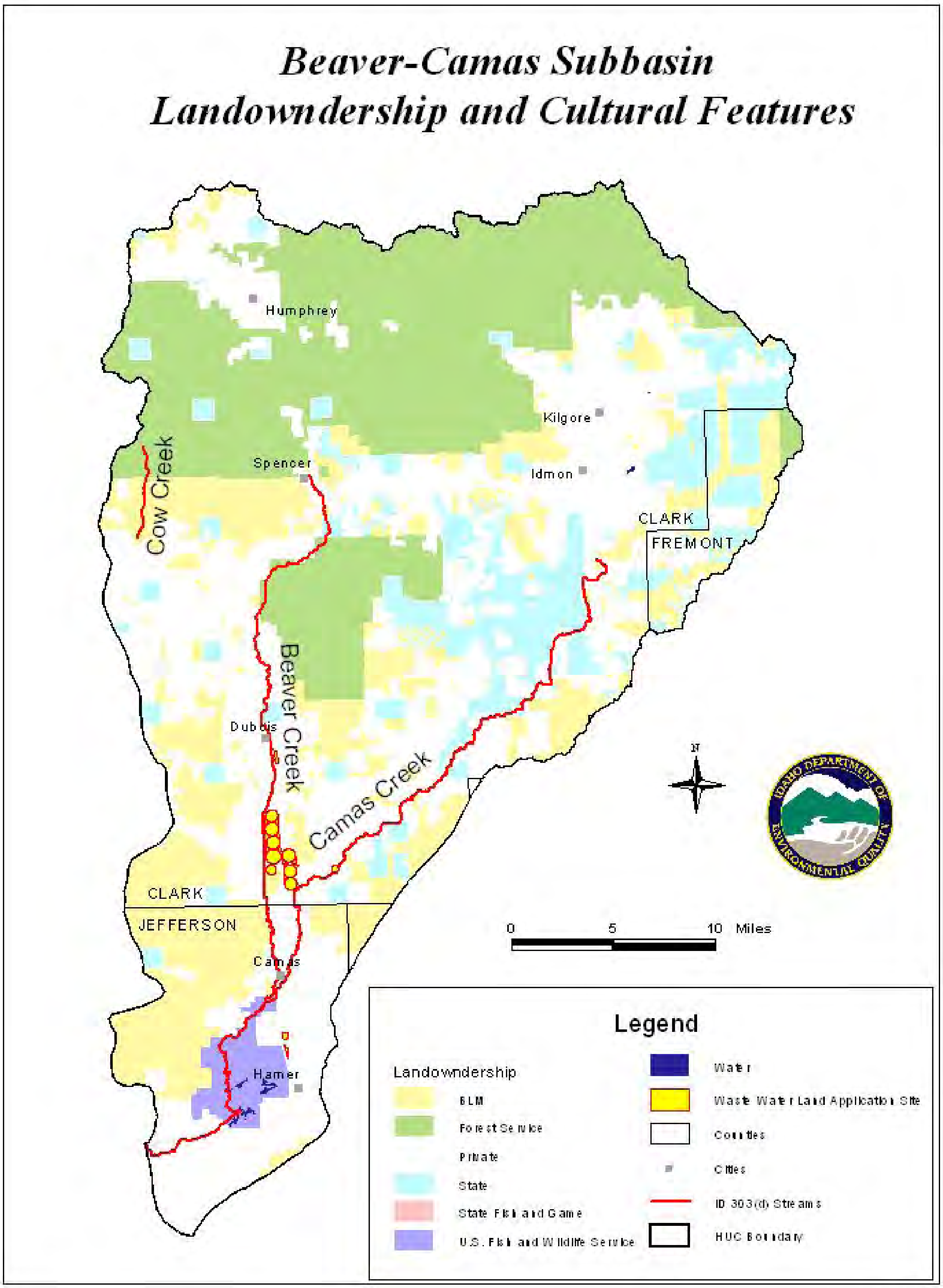


Figure 31. Landownership and Cultural Features of the Beaver-Camas Subbasin.

Mud Lake

Mud Lake, authorized by the Flood Control Act of 1950, is located on the southern tip of the Beaver-Camas watershed, a closed basin on Camas Creek. Mud Lake is Located 20 miles west and 50 miles north of Idaho Falls, in Jefferson County, Idaho. The Lake is formed by a 10-mile-long embankment constructed years ago by local farmers to confine the lake and make it possible to farm the surrounding lands, as well as to provide water elevation so that irrigation canals could deliver water to farms.

Mud Lake is a designated state Wildlife Management Area (WMA), established primarily to preserve and improve nesting habitat for waterfowl. In 1940, the Idaho Department of Fish and Game (IDFG) purchased 607 acres of wetlands, creating Mud Lake WMA. Through the years, acquisition of adjacent land parcels, together with lease agreements and a withdrawal of lands from the U.S. Bureau of Land Management, have expanded Mud Lake WMA to its present 8,853 acres.

Mud Lake is situated on a major Pacific flyway for migratory birds like snow geese, trumpeter swans and ducks. Sand hill cranes, blue herons, and occasionally bald and golden eagles inhabit the area. Moose, elk and antelope are known to be in attendance all year round at the lake. Summer and winter fishing is fantastic, with an exceptional large mouth bass fishery.

Camas National Wildlife Refuge

The Camas national Wildlife Refuge, located off of I-15 near Hamer, Idaho, is one of 500 national wildlife refuges in the country. Each year, during spring and fall, the refuge is filled with migrating songbirds and waterfowls, with numbers peaking at 50,000.

Migratory birds are not the only wildlife that frequent this refuge. Small mammals, such as beavers, coyotes, and cottontails, are often found roaming the fields. Five species of big game also inhabit the area: white-tailed deer, mule deer, pronghorn antelope, moose and elk. Among the endangered and rare species, typical visitors are the bald eagle, peregrine falcon, and trumpeter swan.

About half of the refuge's 10,578 acres are lakes, ponds, and marshlands. The remainder consists of lush grass, sagebrush uplands and meadows.

Water management is a critical component of Camas Refuge operations. An extensive system of canals, dikes, wells, ponds, and water-control structures is used to manipulate water for the benefit of wildlife, with an emphasis on nesting waterfowl. Haying and prescribed fire are used to manipulate vegetation in some fields, and small grain crops are grown to provide supplemental feed for geese and cranes and to keep them from damaging private croplands.

US Sheep Experiment Station

The U.S. Sheep Experiment Station (USSES) is located in the upper Snake River plain at the foothills of the Centennial Mountains, approximately six miles north of Dubois, Idaho, which is the Clark County seat. Clark County contains 1,765 square miles of land and has a population of approximately 980 persons, approximately 500 of whom live in Dubois. The USSES is the second largest employer in Clark County.

In addition to the Dubois location, which serves as the headquarters, the USSES, has research land in two states, Montana and Idaho. The majority of the USSES land is in the Beaver-Camas Subbasin, with smaller portions located close by in Montana. The three locations in the Beaver-Camas Subbasin are the: 1) Headquarters (27,930 acres) near Dubois, 2) Humphrey Ranch (2,600 acres), and 3) the Henninger Ranch near Kilgore (1,200 acres).

The USSES headquarters has office, laboratory, animal, equipment, and residential buildings, dry-lot facilities for research throughout the year, lambing facilities, and lands used for spring and autumn grazing and rangeland research. The Humphrey Ranch has animal facilities and equipment buildings, and is used for spring, summer, and autumn grazing and rangeland research and the Henninger Ranch has animal facilities and is used for summer grazing and rangeland research.

USSES lands range from approximately 4,800 feet to nearly 10,000 feet in elevation, with average annual precipitation that ranges from approximately 10 inches in the Snake River plain to nearly 21 inches in the Centennial Mountains. Because of its diverse geography, USSES lands contain subalpine meadow, foothill, sagebrush steppe, and desert shrubland ecosystems. This diversity provides unparalleled research opportunities.

USSES research will lead to an understanding of the interactions between sheep and the environments in which they are produced that can be used to improve sheep production systems and ensure the sustainability of grazing land ecosystems. (www.ars.usda.gov/main/site_main.htm?modecode=53-64-00-00)

History and Economics

The Beaver-Camas Subbasin is a rural area where the principal economic activities revolve around agriculture. Agriculture has been the principal source of income in the watershed for at least one hundred years.

Dubois, the largest city in the subbasin, is also the Clark County seat. The majority of the population is located in this community and the largest employer is Larsen Farms and the second largest employer in the area is the USSES. The Spencer Opal Mines provide economic opportunities for the residents of Spencer.

2. Subbasin Assessment – Water Quality Concerns and Status

In 1998, DEQ established a new 303(d) list based on 1993-1996 assessments performed Through the Beneficial Use Reconnaissance Program (BURP) and other pertinent material regarding beneficial use status and water quality standards violations. Waters monitored through BURP after 1996 have not been assessed for 303(d) listing purposes. The 1998 303(d) list included five (5) stream segments (six assessment units) in the Beaver-Camas Subbasin (Table 11 and Figure 30). The EPA approved that list in May 2000.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

There are six water quality limited assessment units (AU) in the Beaver-Camas Subbasin, and of the six, only the upper halves of two of the listed segments are perennial; Camas Creek, Spring Creek to Highway 91 and Beaver Creek, Spencer to Dubois. The remaining listed segments are either ephemeral or intermittent streams that do not sustain flows all year long.

Figure 31 shows the 303(d) listed water quality segments in the Beaver-Camas Subbasin. Table 11 summarizes the 303(d) listed waterbody, its boundaries, assessment units, water quality limited segment number, and listing basis.

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses and that do not meet water quality standards must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

About Assessment Units

AUs now define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the Water Body Assessment Guidance (WBAG), second edition (Grafe et al 2002).

Assessment units (AUs) are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—although ownership and land use can change significantly, the AU remains the same.

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers, there is now a direct tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

However, the new framework of using AUs for reporting and communicating needs to be reconciled with the legacy of 303 (d) listed streams. Due to the nature of the court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from "headwater to mouth." In order to deal with the vague boundaries in the listings, and to complete TMDLs at a reasonable pace, DEQ set about writing TMDLs at the watershed scale (HUC), so that all the waters in the drainage are and have been considered for TMDL purposes since 1994.

The boundaries from the 1998 303(d) listed segments have been transferred to the new AU framework, using an approach quite similar to how DEQ has been writing SBAs and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 303(d) listings in Section 5 of the Integrated Report. AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the 303(d) list. This was necessary to maintain the integrity of the 1998 303(d) list and to maintain continuity with the TMDL program. These new AUs will lead to better assessment of water quality listing and de-listing.

When assessing new data that indicate full support, only the AU that the monitoring data represents will be removed (de-listed) from the 303(d) list (Section 5 of the Integrated Report.).

Listed Waters

Table 11 shows the pollutants listed and the basis for listing for each §303(d) listed AU in the subbasin. Not all of the water bodies will require a TMDL, as will be discussed later. However, a thorough investigation, using the available data, was performed before this conclusion was made. This investigation, along with a presentation of the evidence of non-compliance with standards for several other tributaries, is contained in the following sections.

Table 11. §303(d) Segments in the Beaver-Camas Subbasin.

Waterbody Name	WQL SEG	AU of HUC 17040214	1998 §303(d)[1] Boundaries	Pollutants	Listing Basis
Camas Creek	2190	SK001_06	Hwy 91 to Mud Lake	Flow alteration, nutrients, sediment	1996 Carry-0ver
Camas Creek	2191	SK002_05	Spring Creek to Hwy 91	Flow alteration, habitat alteration, nutrients, sediment, and temperature	1996 Carry-over
Beaver Creek	2193	SK003_05 SK014_05	Dubois to Camas Creek	Flow alteration, habitat alteration, nutrients, sediment, and temperature	1996 Carry-over
Beaver Creek	2194	SK015_05	Spencer to Dubois	Flow alteration, habitat alteration, nutrients, sediment, and temperature	1996 Carry-over
Cow Creek	5233	SK018_04	Headwaters to Thunder Gulch	Unknown	Low metric scores

[1]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection "d" of the Clean Water Act.

2.2 Applicable Water Quality Standards

Water Quality standards are legally enforceable rules and consist of three parts: the designated uses of waters, the numeric or narrative criteria to protect those uses, and an antidegradation policy. Water quality criteria used to protect these beneficial uses include narrative “free from” criteria applicable to all waters (IDAPA 58.01.02.200), and numerical criteria, which vary according to beneficial uses (IDAPA 58.01.02.210, 250, 251, & 252). Typical numeric criteria include bacteriological criteria for recreational uses, physical and chemical criteria for aquatic life [e.g. pH, temperature, dissolved oxygen (DO), ammonia, toxics, etc.], and toxics and turbidity criteria for water supplies. Idaho’s water quality standards are published in the State’s rules at *IDAPA 58.01.02 Water Quality Standards and Wastewater Treatment Requirements*. Designated beneficial uses for waters in the Beaver-Camas Subbasin are listed in Table 12.

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

Existing Uses

Existing uses under the CWA are “those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards.” The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a waterbody that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Designated Uses

Designated uses under the CWA are “those uses specified in water quality standards for each water body or segment, whether or not they are being attained.” Designated uses are simply uses officially recognized by the state. In Idaho these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use, such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, an use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Tables 12 and 13 show the beneficial use status of streams in the Beaver-Camas Subbasin. Use designations are assigned to several sections of Beaver and Camas Creeks, many of which are 303(d) listed segments (Table 12).

Existing and presumed uses for streams in the subbasin are listed in Table 13. As mentioned above, the undesignated streams in the watershed are presumed to support CWAL and PCR or SCR. Where data is available, known existing or potential existing uses are identified. Water quality data, particularly fish count data, show that SS has or is supported in all of the remaining streams in the subbasin so, SS is considered an existing use for all of the undesignated streams in the watershed.

Table 12. Beaver-Camas Subbasin designated beneficial uses.

Waterbody	Waterbody Unit (WBID)	Boundaries	Designated Uses[1]	1998 §303(d) List[2]
Camas Creek	1	Beaver Creek to Mud Lake	CWAL, SS, PCR	Yes
Camas Creek	2	Spring Creek to Beaver Creek	CWAL, SS, PCR	Yes
Beaver Creek	3	Canal (T09N, R36E) to mouth	CWAL, SS, PCR, DWS	No
Camas Creek	7	Confluence of West and East Camas Creeks to Spring Creek	CWAL, SS, PCR	No
Beaver Creek	14	Dry Creek to Canal (T09N, R36E)	CWAL, SS, PCR, DWS	Yes
Beaver Creek	15	Rattlesnake Creek to Dry Creek	CWAL, SS, PCR, DWS	Yes
Beaver Creek	18	Miners Creek to Rattlesnake Creek	CWAL, SS, PCR, DWS	Yes
Beaver Creek	20	Idaho Creek to Miners Creek	CWAL, SS, PCR, DWS	Yes
Beaver Creek	21	Source to Idaho Creek	CWAL, SS, PCR, DWS	No

[1]CWAL – Cold Water Aquatic Life, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation, AWS – Agricultural Water Supply, DWS – Domestic Water Supply

[2]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

Table 13. Beaver-Camas Subbasin presumed/existing beneficial uses

Waterbody	Waterbody Unit (WBID)	Boundaries	Presumed/Existing Uses[1]	1998 §303(d) List[2]
Spring Creek	4	Dry Creek to Mouth	CWAL and PCR or SCR/SS	No
Dry Creek	25	Source to Mouth	CWAL and PCR or SCR/SS	No
Ching Creek	6	Source to Mouth	CWAL and PCR or SCR/SS	No
Crooked/Crab Creek	8	Source to Mouth	CWAL and PCR or SCR/SS	No
Warm Creek	9	Cottonwood Creek to mouth and East Camas Creek – T13N, R39E, Sec 20, 6400 ft. elevation to Camas Creek	CWAL and PCR or SCR/SS	No
East Camas Creek	10	From and including Larkspur Creek to T13N, R39E, Sec. 20, 6400 ft elevation	CWAL and PCR or SCR/SS	No
East Camas Creek	11	Source to Larkspur Creek	CWAL and PCR or SCR/SS	No
West Camas Creek	12	Targhee National Forest Boundary (T13N, R38E) to Camas Creek	CWAL and PCR or SCR/SS	No
West Camas Creek	13	Source to Targhee National Forest Boundary (T13N, R38E)	CWAL and PCR or SCR/SS	No
Rattlesnake Creek	16	Source to Mouth	CWAL and PCR or SCR/SS	No
Threemile Creek	17	Source to Mouth	CWAL and PCR or SCR/SS	No
Miners Creek	19	Source to Mouth	CWAL and PCR or SCR/SS	No
Idaho Creek	16	Source to Mouth	CWAL and PCR or SCR/SS	No
Pleasant Valley Creek	23	Source to Mouth	CWAL and PCR or SCR/SS	No
Huntley Canyon Creek	24	Source to Mouth	CWAL and PCR or SCR/SS	No
Dry Creek	25	Source to Mouth	CWAL and PCR or SCR/SS	No
Cottonwood Creek Complex	26	Complex	CWAL and PCR or SCR/SS	No

[1]CW – Cold Water, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation, AWS – Agricultural Water Supply, DWS – Domestic Water Supply
[2]Refers to a list created in 1998 of waterbodies in Idaho that did not fully support at least one beneficial use. This list is required under section 303 subsection “d” of the Clean Water Act.

Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250) (Table 14).

Excess sediment is described by narrative criteria (IDAPA 58.01.02.200.08): "Sediment shall not exceed quantities specified in Sections 250 and 252 or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350."

Narrative criteria for excess nutrients are described in IDAPA 58.01.02.200.06, which states: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses."
Narrative criteria for floating, suspended, or submerged matter are described in IDAPA 58.01.02.200.05, which states: "Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities."

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the Water Body Assessment Guidance (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

Table 14 includes the most common numeric criteria used in TMDLs.

Figure 32 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 14. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria, ph, and Dissolved Oxygen	Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 DO[b] exceeds 6.0 mg/L[c]	pH between 6.5 and 9.5 Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average
Tempera-ture[d]			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October
			Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	
Turbidity			Turbidity shall not exceed background by more than 50 NTU[e] instantaneously or more than 25 NTU for more than 10 consecutive days.	
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Tempera-ture				7 day moving average of 10 °C or less maximum daily temperature for June - September

[a] *Escherichia coli* per 100 milliliters
[b] dissolved oxygen
[c] milligrams per liter
[d] Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
[e] Nephelometric turbidity units

2.3 Pollutant/Beneficial Use Support Status Relationships

Most of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been altered by humans. That is, streams naturally have sediment, nutrients, and the like, but when anthropogenic sources cause these to reach unnatural levels, they are considered “pollutants” and can impair the beneficial uses of a stream.

Temperature

Temperature is a water quality factor integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether a warm, cool, or coldwater aquatic community is present. Many factors, natural and anthropogenic, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated steam temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower threshold value than the adults, manifesting in retarded growth rates. High temperatures also affect embryonic development of fish before they even emerge from the substrate. Similar kinds of affects may occur to aquatic invertebrates, amphibians and mollusks, although less is known about them.

Sediment

Both suspended (floating in the water column) and bedload (moves along the stream bottom) sediment can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases eventually lead to death. Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment.

Organic suspended materials can also settle to the bottom and, due to their high carbon content, lead to low intergravel DO through decomposition.

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

Settleable solids are defined as the volume (milliliters [ml]) or weight (mg) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45 µm (micrometer) filter (Standard Methods 1975, 1995). Settleable solids and TSS both contain nutrients that are essential for aquatic plant growth. Settleable solids are not as nutrient rich as the smaller TSS, but they do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate that is exposed to light, facilitating additional macrophyte growth.

2.4 Summary and Analysis of Existing Water Quality Data

Water quality data available for the Beaver-Camas Subbasin was provided by multiple government agencies collecting data in the watershed, as shown by appendix D. All continuous flow data was provided by the USGS. Water column data, such as stream temperatures, nutrient, pathogen, etc. was collected by the DEQ and BLM. Temperature data was provided by the BLM, USFS, and DEQ. DEQ has contributed BURP, streambank erosion inventory, and subsurface sediment data. The BLM provided information on riparian conditions. DEQ, IDFG, USFS, and BLM collected and provided fish data.

Flow Characteristics

As discussed in section 1.2 of this document, the Beaver-Camas Subbasin has very unique hydrologic features. Two of the most distinct are: 1) the massive natural infiltration of stream surface water and 2) the introduction of groundwater via wells into Camas Creek and ultimately Mud Lake.

USGS gauge station data is available for Beaver and Camas Creeks (Figure 32). As shown in Table 15, active and inactive station data available. It is useful to evaluate data from inactive stations because it allows for the opportunity to look at historic trends and gain an impression of long term hydrologic cycles in the watershed.

Table 15. USGS gauge station data.

Station Name and Number	Location	Period of Record	Drainage Area (mi^2)	Highest Annual Mean (cfs)	Lowest Annual Mean (cfs)	Highest Monthly Mean (cfs)	Lowest Monthly Mean (cfs)
Camas Creek near Kilgore 13109000	N44.28333° W111.91667°	1921-1930	215	ND	ND	691 (May 1921)	11.9 (Jun 1924)
Camas Creek at Red Rd nr Kilgore 13108900	N44.28889° W111.89389°	1985-1991		125 (1986)	31 (1991)	519 (May 1986)	1.63 (Aug 1991)
Camas Creek at 18Mile near Kilgore 13108500	N44.29722° W111.90566°	1937-1973	210	158 (1971)	55 (1949)	1141 (May 1969)	2 (Feb 1949)
Camas Creek near Camas 13111500	N44.07028° W112.19778°	1921-1926	285	14.4 (1925)	35.7 (1925)	229 (May1921)	6.65 (Dec 1924)
Camas Creek at Camas 13112000	N44.00278° W112.22000°	1925-2003	400	91.8 (1995)	0.8 (1934)	536 (June 1952)	0
Beaver Creek at Spencer 13113000	N44.35556° W112.17778°	1940-1993	220	79.9 (1971)	10.8 (1992)	387 (1969)	0 (1988)
Beaver Creek at Dubois 13113500	N44.18611° W112.23556°	1921-1987	220	197.8 (1969)	0 (1934)	473 (June 1969)	0
Beaver Creek near Camas 13114000	N44.00750° W112.22361°	1921-1991	510	45.8 (1969)	0	213 (1969)	0

The gauge station data depicted in Figures 33 through 48, adequately illustrates how diverse the hydrology in the subbasin is. Stations #13109000 (1921-1930), #13108500 (1937-1973), and #13108900 (1985-1991) are all located near the headwaters of Camas Creek, near Eighteenmile. The three datasets combined, roughly cover streamflow from 1921 through

1991 showing that flows are maintained in Camas Creek all year long and that there is a significant peak in the spring with an all time high streamflow recorded in 1969 in excess of 2500 cubic feet per second (cfs). Figures 33 through 38 show that on an annual basis the flows are very divergent with peaks roughly averaging around 800 cfs and base flows nearing 10 cfs.

The two remaining stations on Camas Creek are located downstream near Camas. The older station (#13111500) recorded flow data from 1921-1926 and the active station (#13112000) has been recording data since 1925. As shown by Figures 39 through 42, the highest peak recorded occurred in 1997 around 1500 cfs. The station data illustrates that since the mid 1980's streamflows in Camas Creek, at Camas have consistently reached zero cfs on a seasonal basis.

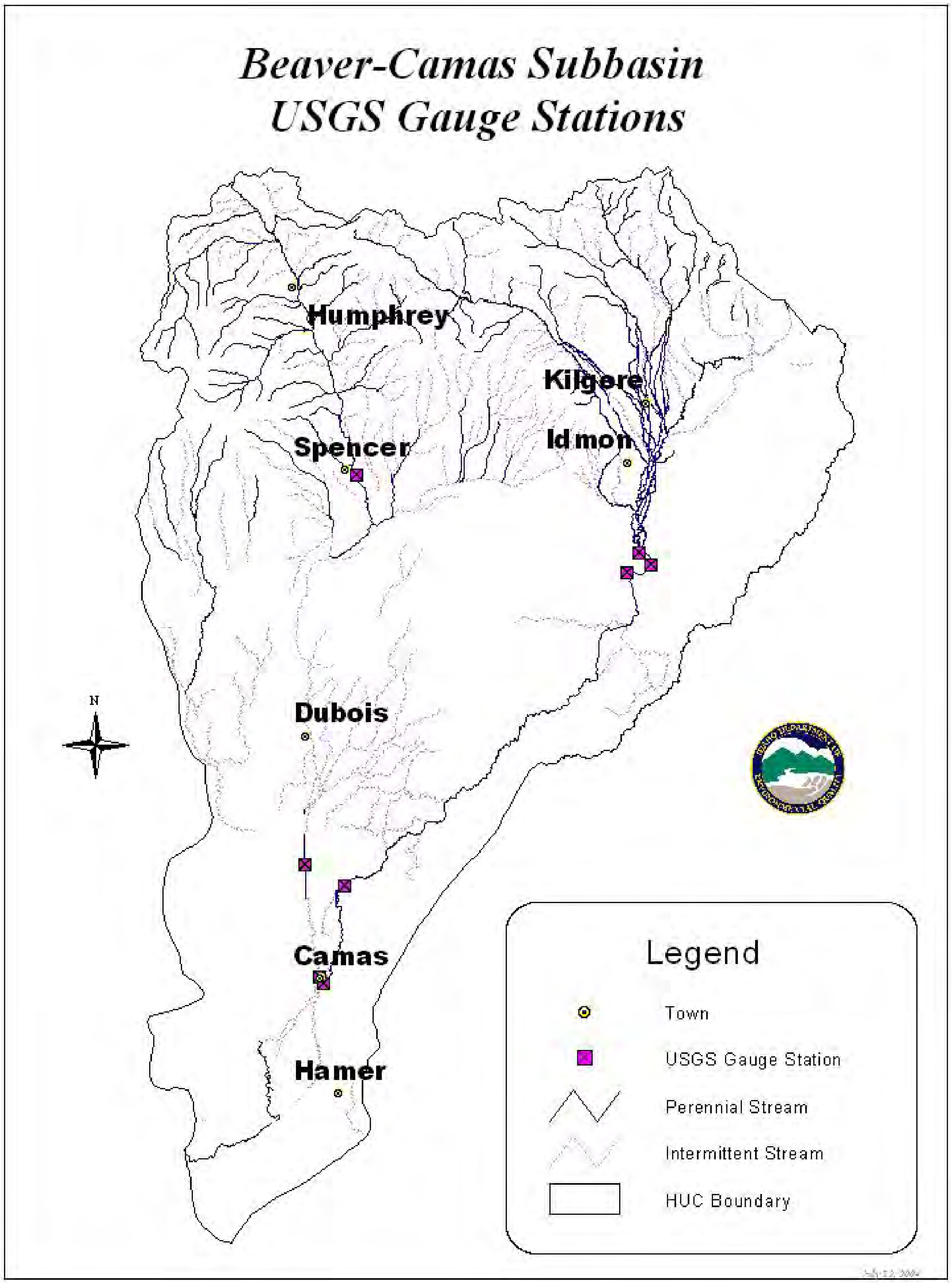


Figure 32. USGS Gauge Station Locations.

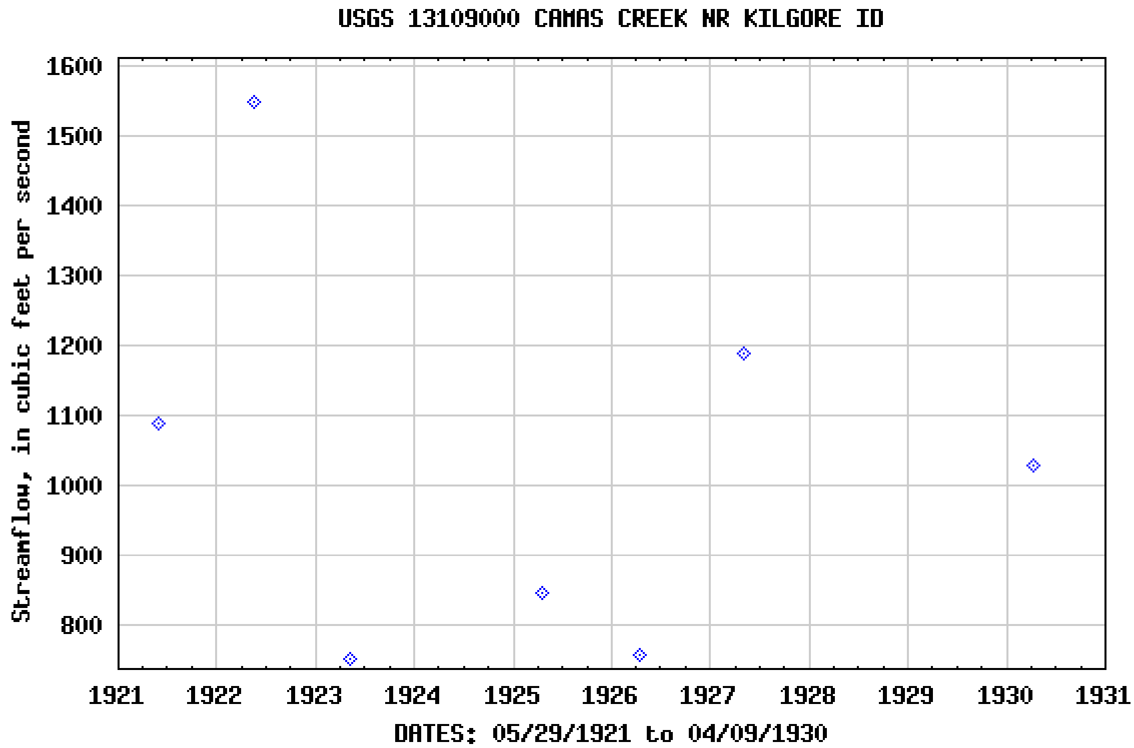


Figure 33. Peak Streamflow (cfs) for station# 1310900, Camas Creek near Kilgore, ID (1921-1930).

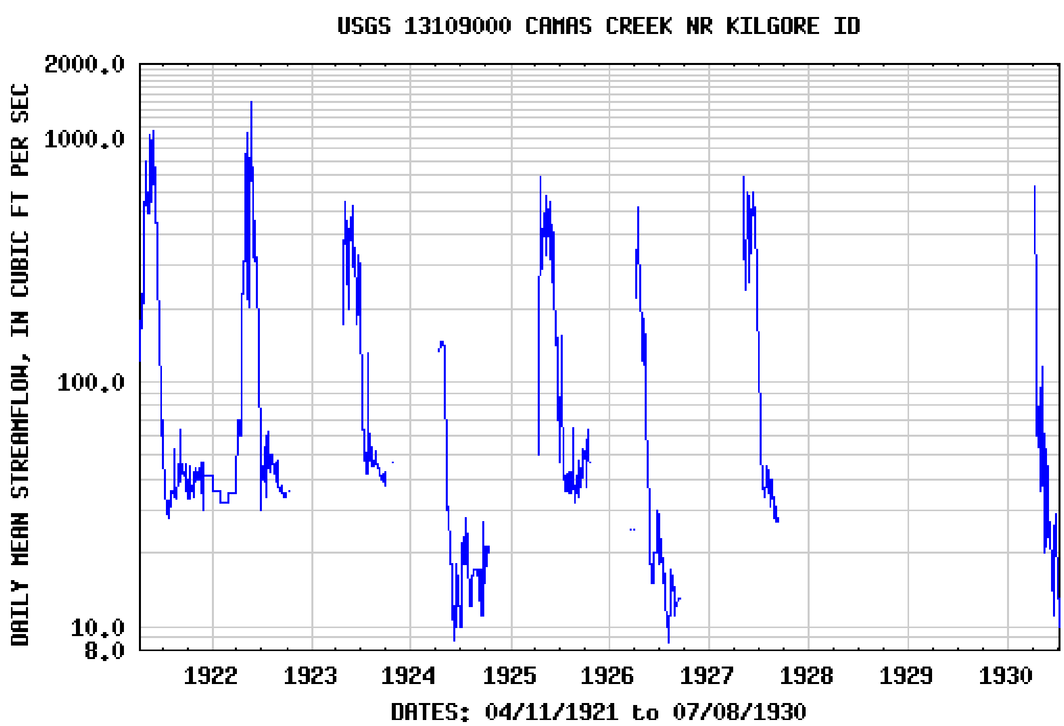


Figure 34. Daily Mean Streamflow (cfs) for Station #13108500, Camas Creek near Kilgore, ID (1921-1930).

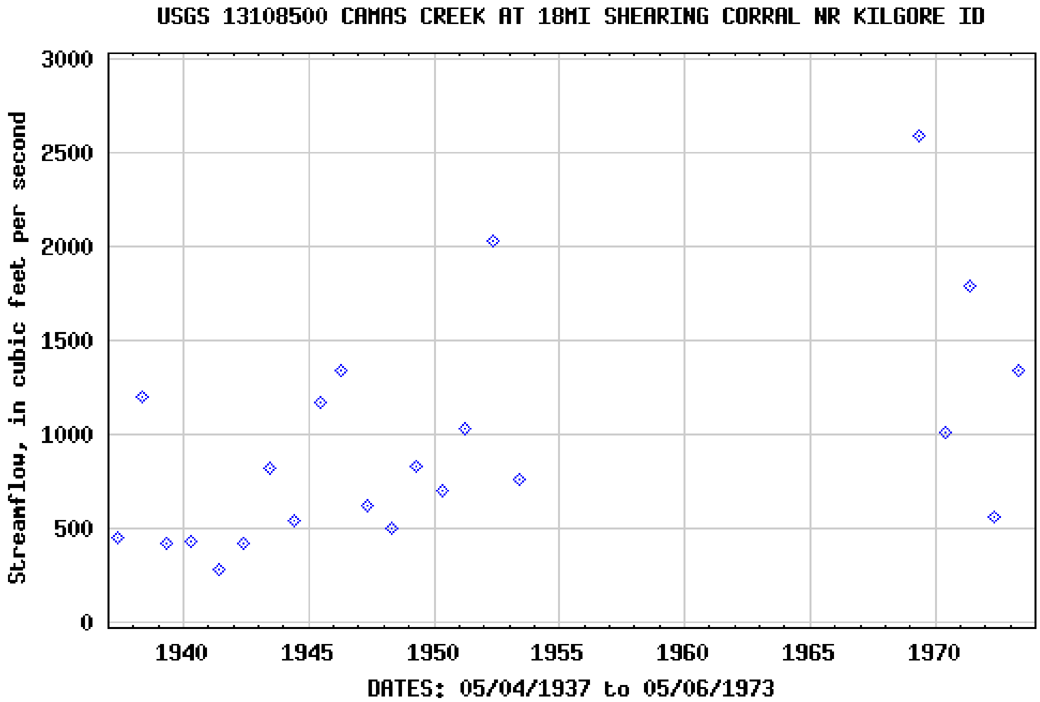


Figure 35. Peak Streamflow (cfs) for Station #13108500, Camas Creek at 18 mile Shearing Corral near Kilgore, ID (1937-1973)

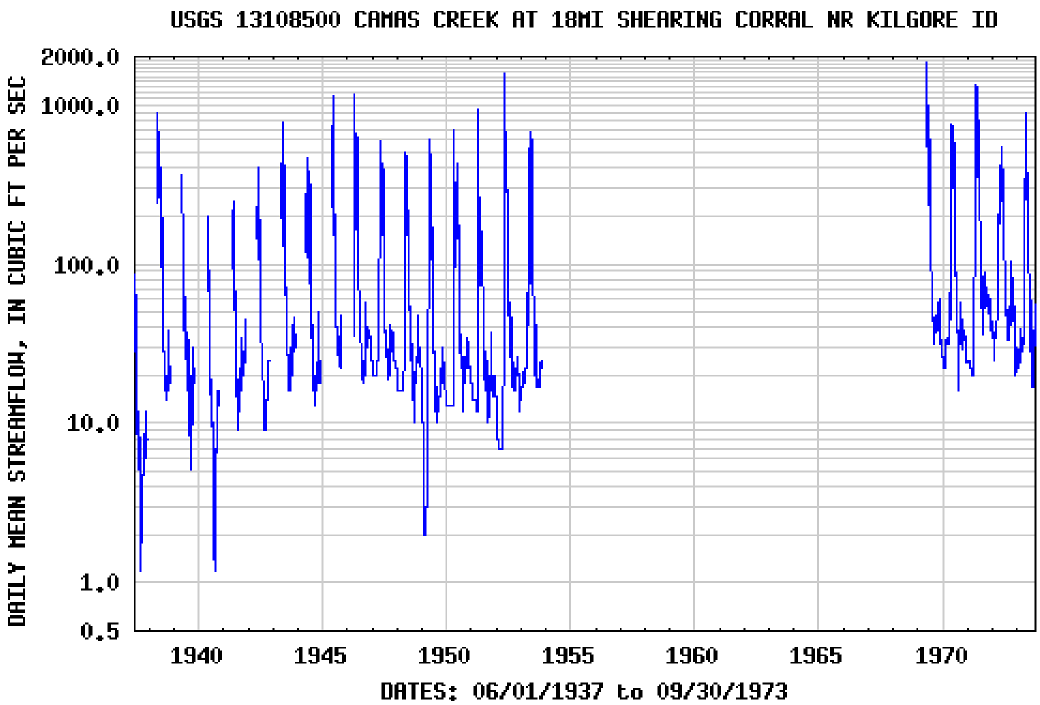


Figure 36. Daily Mean Streamflow (cfs) for Station #13108500, Camas Creek at 18 mile Shearing Corral near Kilgore, ID (1937-1973).

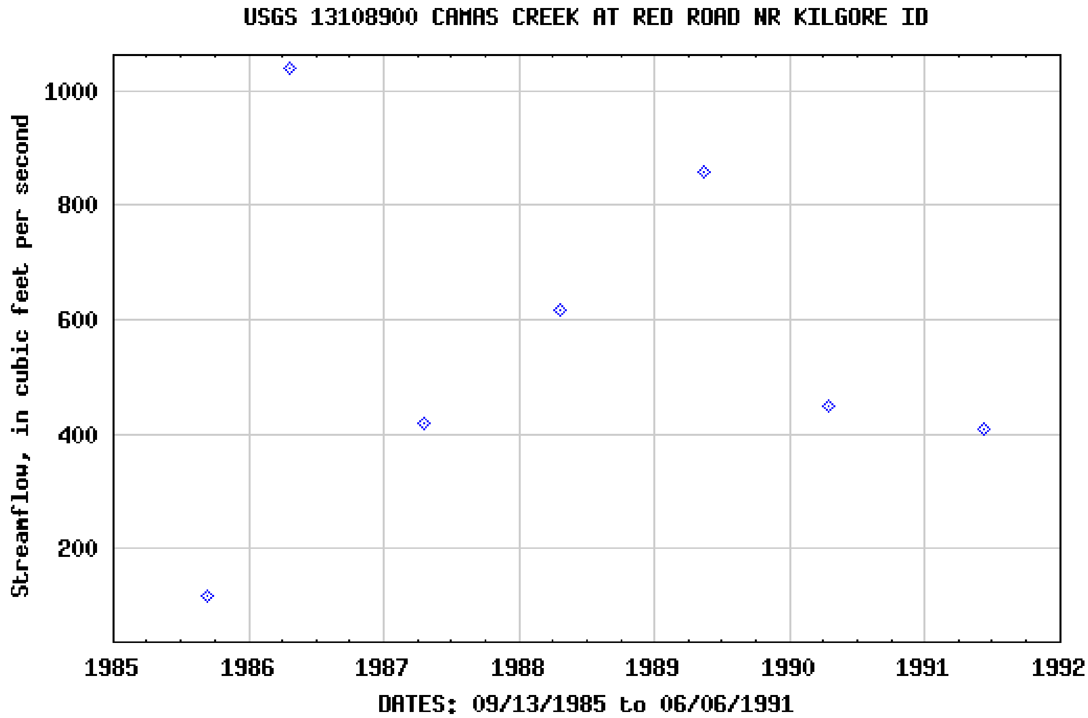


Figure 37. Peak Streamflow (cfs) for Station #1308900, Camas Creek at Red Road Near Kilgore (1985-1991).

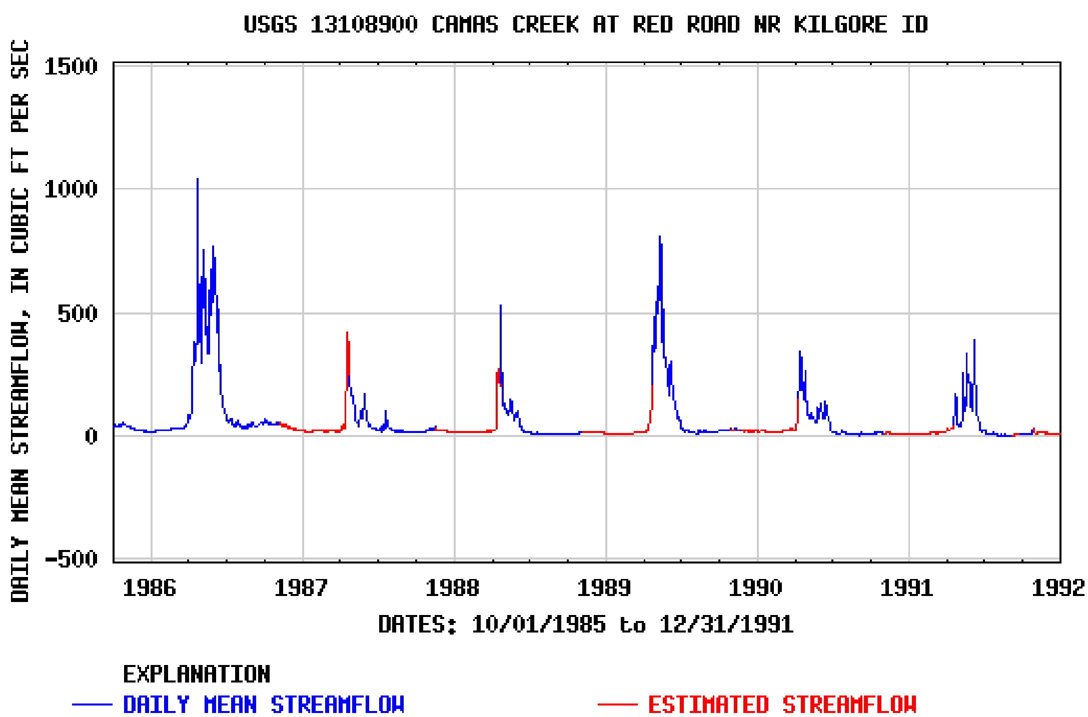


Figure 38. Daily Mean Streamflow (cfs) for Station #1308900, Camas Creek at Red Road Near Kilgore (1985-1991).

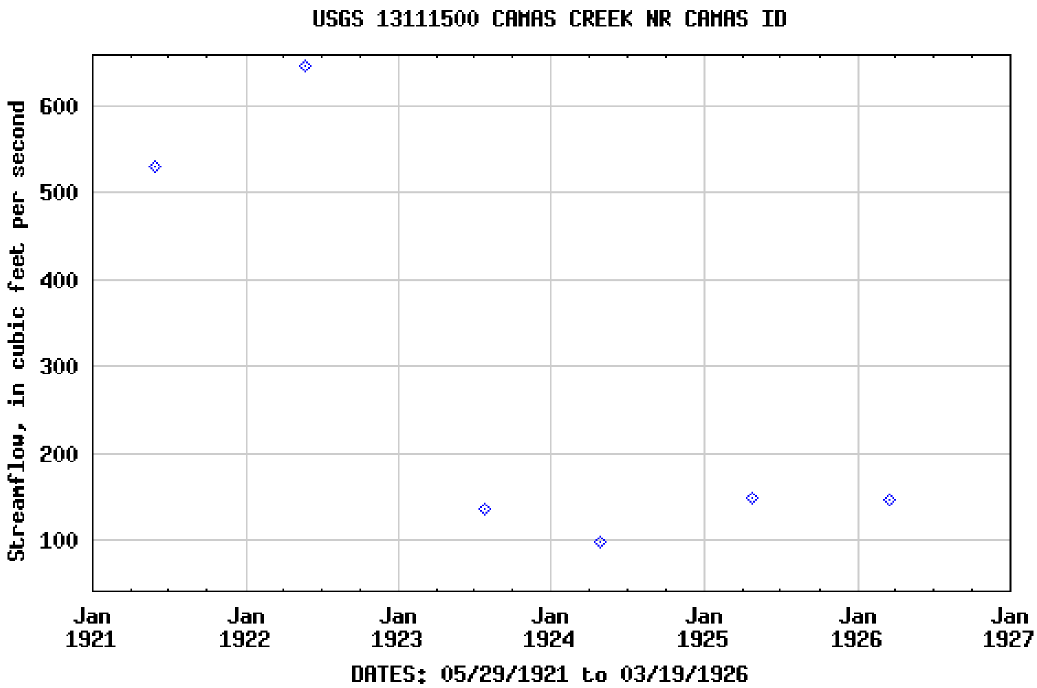


Figure 39. Peak Streamflow (cfs) for Station #1308900, Camas Creek Near Camas, ID (1921-1926).

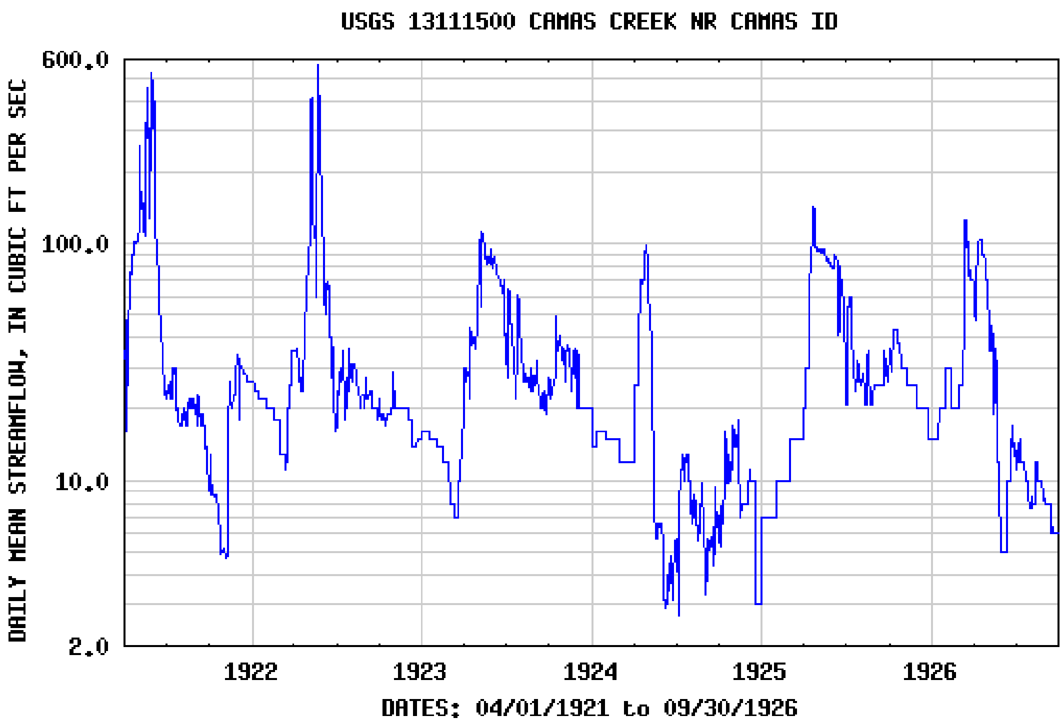


Figure 40. Daily Mean Streamflow (cfs) for Station #1308900, Camas Creek Near Camas, ID (1921-1926).

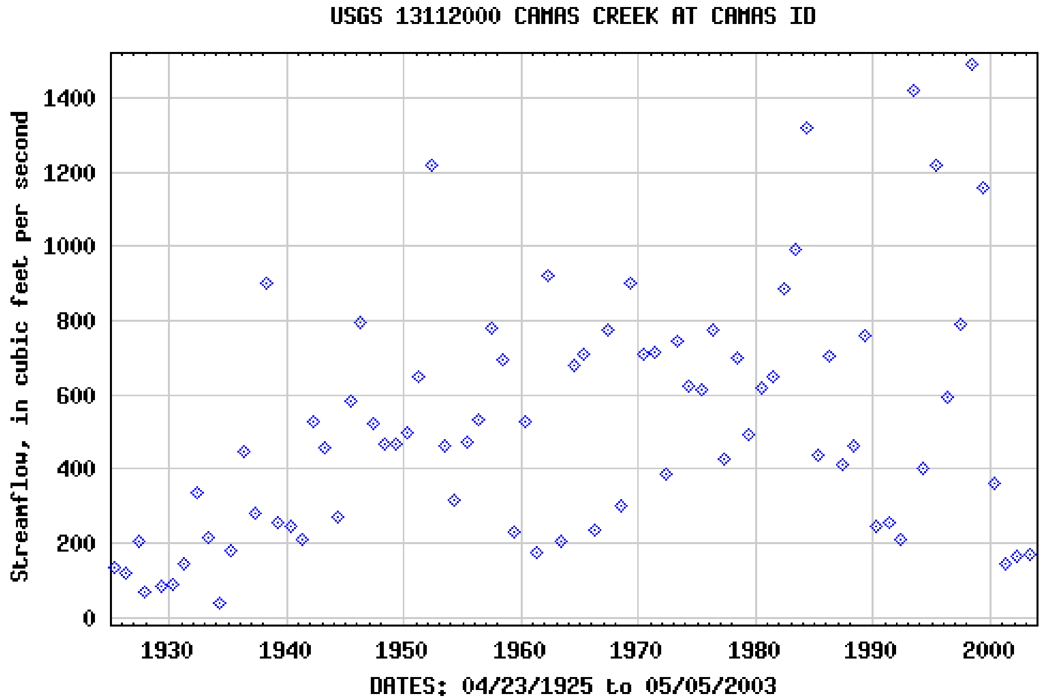


Figure 41. Peak Streamflow (cfs) for Station #13112000, Camas Creek at Camas, ID (1925-2003).

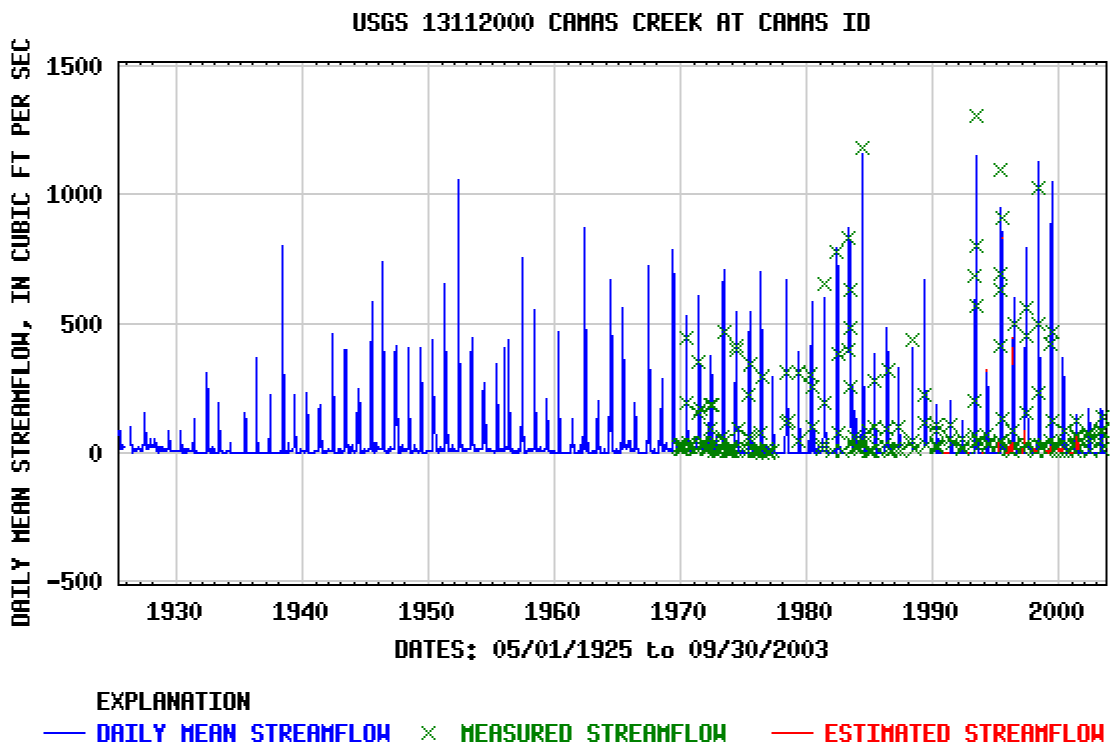


Figure 42. Daily Mean Streamflow (cfs) for Station #13112000, Camas Creek at Camas, ID (1925-2003).

USGS gauge station data is available for three locations (Figure 32) on Beaver Creek, station #1311300 (1940-1993), at Spencer, station #13113500 (1921-1987) at Dubois, and station #13114000 (1921-1991), near Camas.

The station at Spencer shows that a maximum peak streamflow near 1200 cfs was achieved in 1975, as shown in Figure 43. Daily mean data (Figure 44) for this station shows that Beaver Creek streamflow is perennial in this location.

Peak streamflow data (Figure 45) for Beaver Creek at Dubois show that a high peak around 850 cfs was achieved in 1930 and a low of zero cfs was recorded four years later in 1934. Figure 46 shows that Beaver Creek quite often does not sustain a year round flow. Since the data is only through 1987, it should be noted that locals recollect that an annual sustained flow was not achieved in the 1990's or early 2000's.

The furthest downstream gauge station is located further downstream in Camas. A maximum peak nearing 500 cfs was recorded in 1984 and minimums of zero cfs are commonly recorded (Figure 47). Figure 48 shows that Beaver Creek, in this location, is not perennial. A peak is sometimes observed in the early spring for a couple of weeks during the peak spring runoff and then the stream remains dry for the rest of the year.

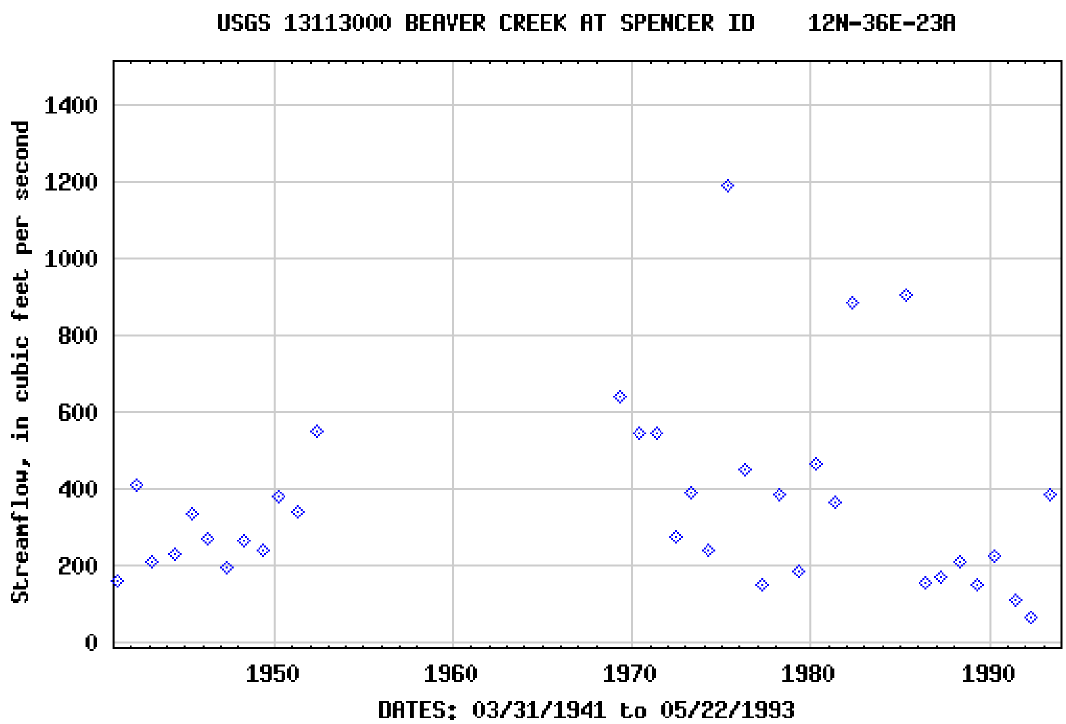


Figure 43. Peak Streamflow (cfs) for Station #13113000, Beaver Creek at Spencer (1940-1993).

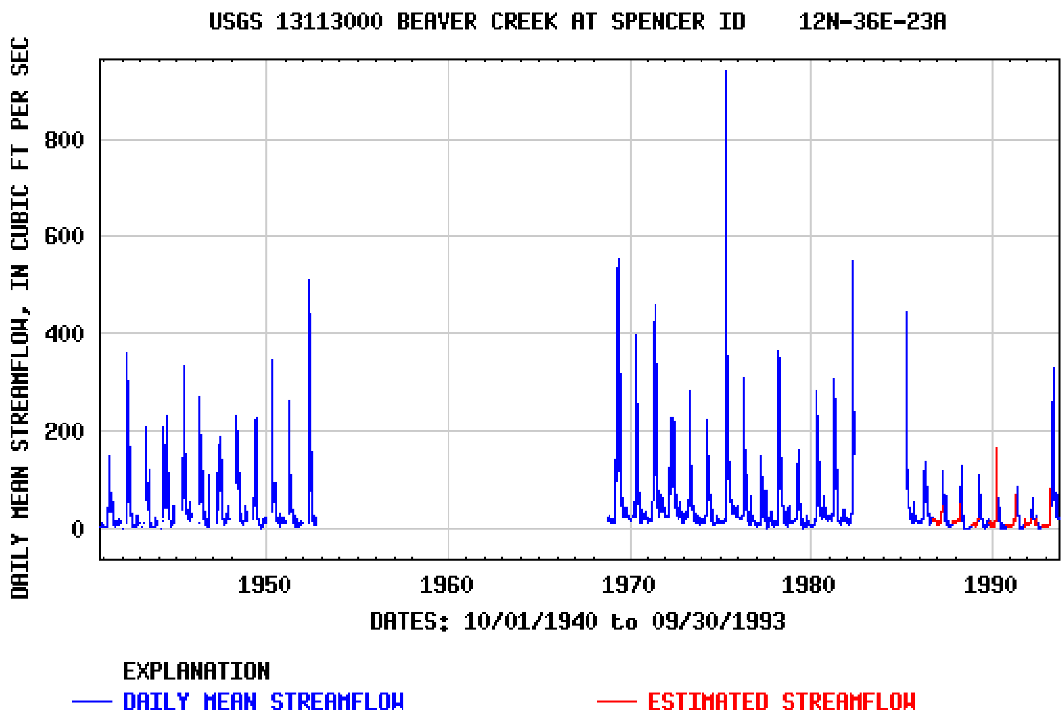


Figure 44. Daily Mean Streamflow (cfs) for Station #13113000, Beaver Creek at Spencer (1940-1993).

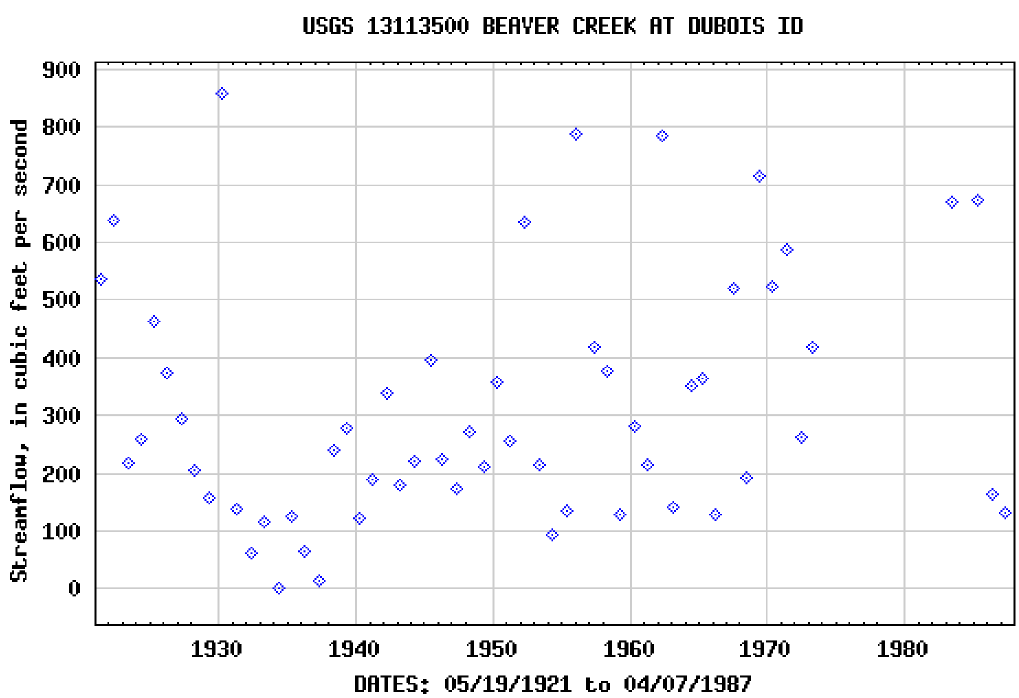


Figure 45. Peak Streamflow (cfs) for Station #13113500, Beaver Creek at Dubois (1921-1987).

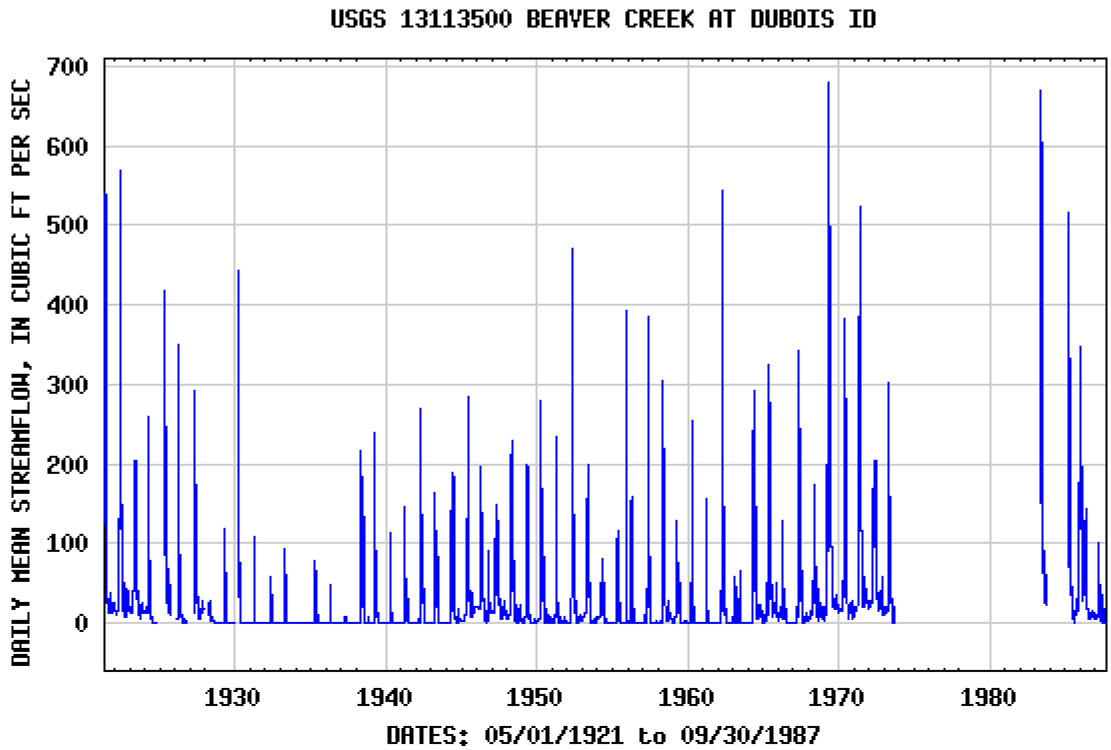


Figure 46. Daily Mean Streamflow (cfs) for Station #13113500, Beaver Creek at Dubois (1921-1987).

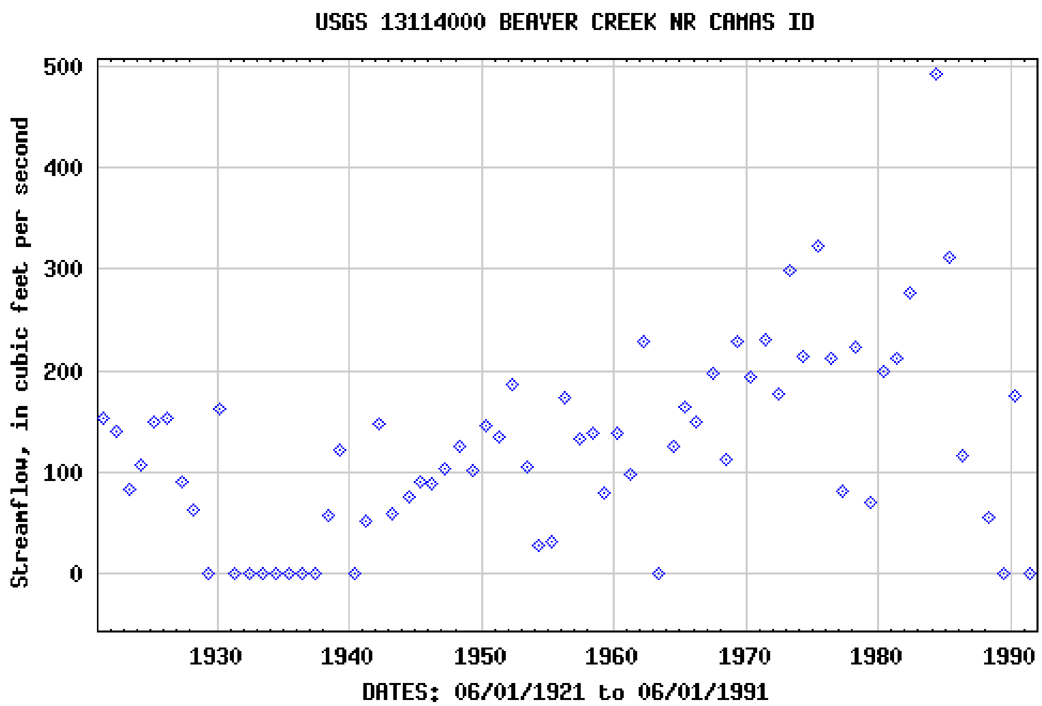


Figure 47. Peak Streamflow (cfs) for Station #13114000, Beaver Creek at Dubois (1921-1991).

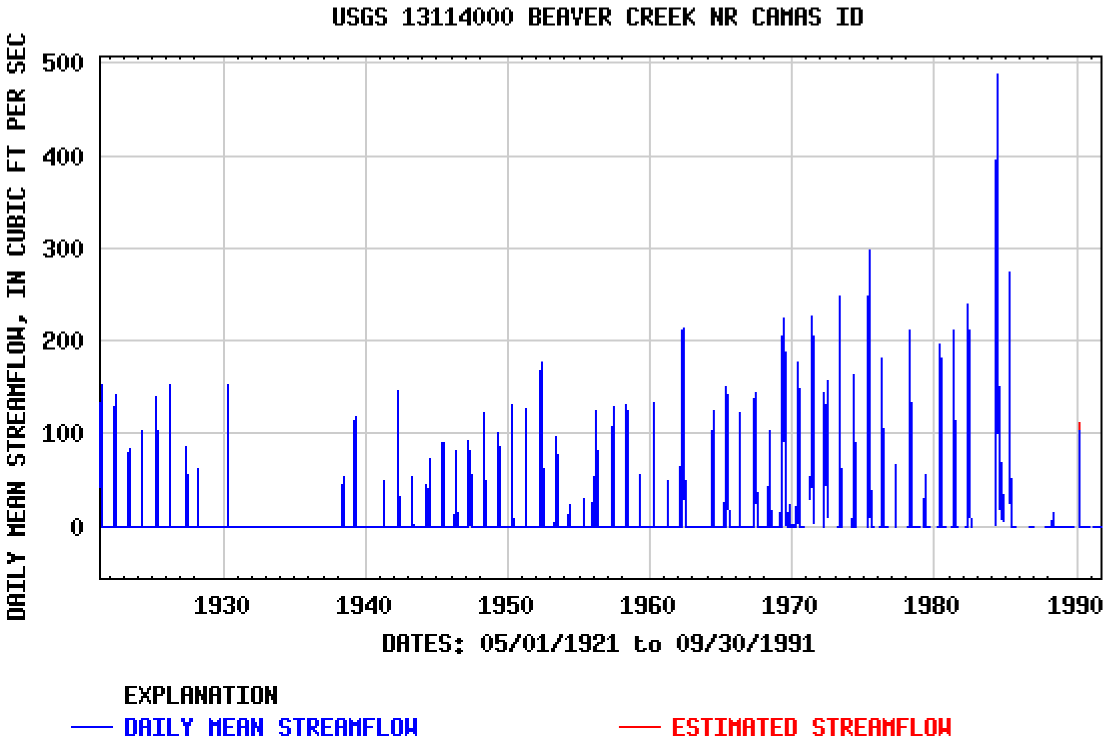


Figure 48. Daily Mean Streamflow (cfs) for Station #13114000, Beaver Creek at Dubois (1921-1991).

Water Column Data

Stream Temperature Data

DEQ and USFS have collected stream temperature data in the Beaver-Camas Subbasin (Tables 16-19). DEQ stream temperature data was collected in 2004 from May through October. Thermologgers were placed in Beaver Creek, Stoddard Creek, Camas Creek, Miners Creek, Dairy Creek, Modoc Creek, Threemile Creek, Crooked Creek, and West Fork Rattlesnake Creek. USFS maintained three temperature sensor locations in the subbasin, data was collected on USFS property in Beaver Creek (above Spencer) from 2000 through 2003, in West Camas Creek in 2002, and in East Camas Creek in 2003.

Raw stream temperature data was obtained and evaluated for State of Idaho water temperature criteria for all of these sites. These criteria are in two categories: cold water aquatic life (CWAL) and salmonid spawning (SS). The temperature criteria for CWAL is 22°C (66.2°F) or less, with a maximum daily average of no greater than 19°C (71.6°C). A CWAL criterion is evaluated for the summer season (June 22 through September 21). The criterion for salmonid spawning is 13°C (55.4°F) or less with a maximum daily average no greater than 9°C (48.2°F). (IDAPA 58.01.02.250.02) According to IDFG, spring SS generally occurs between the first of May and the middle of July. Fall spawning is known to occur from September 15th through November 15th (Fredericks 2004).

A major exceedance of temperature criteria occurs when the criteria are exceeded 10% of the time. See Tables 16-19 for temperature exceedances on each site and the thermograph location(s) for each stream. Major exceedances (>10%) are shaded in gray on the tables.

As shown in Tables 16 and 17, stream temperature data was collected in 2004 by the DEQ in ten locations. Stream temperatures were collected in two temperature listed reaches; Beaver Creek (Spencer gauge) and Camas Creek (headwaters). Stream temperature data show that major exceedances for CWAL and SS were documented in 2004. In Beaver Creek, major exceedances for the 22°C instantaneous CWAL and SS criteria were documented.

Crooked Creek is severely flow altered and flows are significantly reduced and temperatures are not representative natural stream hydrology. Threemile Creek, above the logger site, is flow altered however, flows above near one cfs are maintained in the stream year long. Hydrologically, West Fork Rattlesnake Creek is an intermittent stream with a dry streambed naturally occurring early in the summer. In 2004, stream flows in Miners Creek and Stoddard Creek were less than one cubic feet per second from May through October however, it is known that flows above one cfs are usually maintained in both of the streams.

Dairy Creek and Modoc Creek sample sites maintained constant flows above one cfs the entire summer. No major exceedances in the CWAL criteria were evaluated however, major exceedances in the SS criteria were documented in all four locations.

Three temperature measurement sites were maintained by the USFS in 2000-2003. As shown in Figures 18 and 19 this data yielded an exceedance in the CWAL criteria on Beaver Creek in 2002 and 2003 and major exceedances of the SS criteria on all three streams, every year sampled.

Table 16. 2004 DEQ temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria during the entire monitoring period.

		Cold Water Aquatic Life						
			22°C Inst.			19°C Daily Ave.		
Stream Name	**Date Period**	**# Days Evaluated**	**# Days Over**	**Max Temp**	**Max Date**	**# Days Over**	**Max Temp**	**Max Date**
Beaver Creek, Spencer Gauge	06/21/04-09/22/04	94	10	24.01	13-Aug	2	19.35	16-Jul
Stoddard Creek, near Mouth	06/21/04-09/22/04	94	0	20.19	14-Jul	0	15.71	15 -Jul
Camas Creek, Mouth @ Gauge	06/21/04-09/22/04	94	31	26.34	16-Jul	31	22.49	16-Jul
*Miners Creek, @ near Sheep Cr Rd.	06/21/04-09/22/04	94	8	25.2	17-Jul	2	19.72	17-Jul
Dairy Creek, Rd x-ing near mouth	06/21/04-09/22/04	94	3	22.86	16-Jul	0	17.9	16-Jul
Modoc Creek, mouth	06/21/04-09/22/04	94	0	20.02	23-Jun	0	14.74	17-Jul
Modoc Creek, forest boundary	06/21/04-09/22/04	94	0	20.95	17-Jul	0	14.83	17-Jul

*Crooked Creek, BLM	06/21/04-09/22/04	94	0	20.19	14-Jul	0	16.84	15-Jul
*Threemile Creek, Kligore Rd X-ing	06/21/04-09/22/04	92	53	29.4	16-Jul	4	19.92	16-Jul
* W. Fk. Rattlesnake, Kilgore Rd X-ing	06/21/04-06/25/04	5	3	24.8	23-Jun	0	15.8	24-Jun

* indicates flow altered or intermittent stream

Table 17. 2004 DEQ temperature data and number of days where water temperatures exceeded the salmonid spawning criteria during the entire monitoring period.

		Salmonid Spawning						
			13°C Inst.			9°C Daily Ave.		
Stream Name	**Date Period**	**# Days Evaluated**	**# Days Over**	**Max Temp**	**Max Date**	**# Days Over**	**Max Temp**	**Max Date**
Beaver Creek, Spencer Gauge	05/05/04-7/15/04 09/15/04-10/24/04	112	61	23.24	15-Jul	80	19.09	15-Jul
Stoddard Creek, near Mouth	05/05/04-7/15/04 09/15/04-10/24/04	112	50	20.19	14-Jul	53	15.73	19-Jul
Camas Creek, headwaters @ Gauge	05/06/04-07/15/04 9/15/04-10/24/04	111	65	25.95	15-Jul	85	22.06	15-Jul
*Miners Creek, @ near Sheep Cr Rd.	05/06/04-07/15/04 9/15/04-10/24/04	112	71	23.6	15-Jul	73	18.97	15-Jul
Dairy Creek, Rd x-ing near mouth	05/05/04-07/15/04 9/15/04-10/24/04	112	58	22.48	15-Jul	62	17.84	15-Jul
Modoc Creek, mouth	05/05/04-07/15/04 9/15/04-10/24/04	112	50	20.02	23-Jun	47	14.46	15-Jul
Modoc Creek, forest boundary	05/05/04-07/15/04 9/15/04-10/24/04	112	46	20.19	15-Jul	41	14.71	15-Jul
*Crooked Creek, BLM	05/06/04-07/15/04 9/15/04-10/24/04	111	47	20.19	14-Jul	51	16.84	15-Jul
*Threemile Creek, Kligore Rd X-ing	05/05/04-07/15/04 9/15/04-10/24/04	112	76	27.5	15-Jul	79	19.1	15-Jul
* Fk Rattlesnake, Kilgore Rd X-ing	05/05/04-07/15/04 9/15/04-10/24/04	52	30	24.8	23-Jun	24	15.8	24-Jun

Table 18. 2000, 2001, 2002, and 2003 USFS Temperature data and number of days where water temperatures exceeded the cold water aquatic life criteria during the entire monitoring period.

		Cold Water Aquatic Life						
			22°C Inst.			19°C Daily Ave.		
Stream Name	**Date Period**	**# Days Evaluated**	**# Days Over**	**Max Temp**	**Max Date**	**# Days Over**	**Max Temp**	**Max Date**
Beaver Creek, above Spencer	07/08/00-09/21/00	76	1	22.06	30-Jul	0	18.83	31-Jul
Beaver Creek, above Spencer	06/21/01-09/03/01	74	0	20.2	03-Jul	0	18.03	07-Jul
Beaver Creek, above Spencer	06/21/02-09/22/02	92	12	23.9	13-Jul	6	19.7	15-Jul

Beaver Creek, above Spencer	06/26/04-09/04/03	71	23	25.2	21-Jul	16	21.2	24-Jul
West Camas Creek	06/21/02-09/22/02	92	5	22.7	15-Jul	4	20.0	15-Jul
East Camas Creek	06/26/03-09/22/03	88	0	20.7	24-Jul	0	16.4	24-Jul

Table 19. 2000, 2001, 2002, and 2003 USFS Temperature data and number of days where water temperatures exceeded the salmonid spawning criteria during the entire monitoring period.

		Salmonid Spawning						
			13°C Inst.			9°C Daily Ave.		
Stream Name	**Date Period**	**# Days Evaluated**	**# Days Over**	**Max Temp**	**Max Date**	**# Days Over**	**Max Temp**	**Max Date**
Beaver Creek, above Spencer	07/08/00-07/15/00 09/15/00-09/21/00	15	13	21.73	15-Jul	14	17.48	15-Jul
Beaver Creek, above Spencer	06/16/01-07/15/01	30	30	20.24	03-Jul	30	18.31	03-Jul
Beaver Creek, above Spencer	06/20/02-07/15/02 09/15/02-09/22/02	57	30	23.92	13-Jul	33	19.74	15-Jul
Beaver Creek, above Spencer	06/26/03-07/15/03	20	20	23.52	12-Jul	20	19.42	12-Jul
West Camas Creek	06/15/02-07/15/02 09/15/02-09/22/02	62	34	22.68	15-Jul	37	20.04	15-Jul
East Camas Creek	06/26/03-07/15/03 09/15/03-09/22/03	29	19	18.94	11-Jul	19	13.52	14-Jul

Nutrient Data

Excessive concentrations of nutrients, specifically nitrogen and phosphorous, may diminish water quality and impair beneficial uses through the process of eutrophication. According to IDAPA 58.01.02.200.06, surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growth impairing designated beneficial uses. To protect against the impairment of designated beneficial uses due to excess nutrients, numeric targets have been established by the EPA at 0.1 mg/L Total Phosphorus (TP) in streams not discharging directly into a lake or reservoir, 0.05 mg/L TP in streams were the water enters the reservoir, and 0.3 mg/L nitrate (NO_3) + Nitrite (NO_2) Nitrogen. (EPA 1986)

Table 20 shows the nutrient associated data for several locations in the Beaver-Camas Subbasin. The data was collected by the DEQ in 2004 and in one location on Beaver Creek by the BLM in 2004. Every location met the nutrient criteria, with the exception of one, the E. Fk. Rattlesnake Creek site. Nitrate (NO_3) + Nitrite (NO_2) Nitrogen concentrations were 1.08, significantly above the 0.3 mg/L criteria.

Table 20. DEQ and BLM Nutrient Monitoring Data.

Location	Date	Flow (cfs)	E.coli (CFU/100ml)	NO3/NO2 as N (mg/L)	TKN (mg/L)	Ortho-phosphate PO4 (mg/L)	Total P (mg/L)

Beaver Creek – BLM Site (Upper at BLM exclosure)	08/24/04			0.23	0.23	0.014	0.031
Beaver Creek (Spencer gauge)	05/04/04			<0.05	<0.05	<0.05	<0.05
Beaver (Humphrey)	05/03/04		<2	<0.05	<0.05	<0.05	<0.05
Ching Creek (BLM Property)	05/04/04		43	<0.05	<0.05	<0.05	<0.05
	07/22/04		613	<0.05	0.94	<0.05	0.05
Camas Creek (upper gauge)	05/24/04			<0.05	<0.05	0.05	0.06
	07/22/04			<0.05	0.94	0.05	0.09
Crooked Creek (BLM Property)	05/24/04	2.0		<0.05	1.01	<0.05	<0.05
	07/21/04		345	<0.05	0.85	<0.05	0.08
Modoc Creek (forest boundary)	05/03/04	1.1	228	<0.05	<0.05	<0.05	<0.05
	07/21/04		980	<0.05	0.85	<0.05	0.08
Modoc Creek (upper at ford)	05/03/04		20	<0.05	<0.05	<0.05	<0.05
E. Fk. Rattlesnake Creek (Kilgore Rd. X-ing)	05/04/04		5	1.08	<0.05	<0.05	<0.05
	05/24/04			0.96	<0.05	<0.05	<0.05
Stoddard Creek (service rd x-ing)	05/03/04	0.5	13	<0.05	<0.05	<0.05	<0.05
Dairy Creek (Rd X-ing near mouth)	05/04/04	1.5		<0.05	<0.05	<0.05	0.05
Miners Creek (abandoned ford near Sheep Cr. Rd)	05/04/04	0.7	75	<0.05	<0.05	<0.05	<0.05
Threemile Creek (Kilgore Rd. X-ing)	05/04/04	7.7	115	<0.05	<0.05	<0.05	<0.05
Warm Creek (Kilgore Rd X-ing)	05/04/04		53	<0.05	<0.05	<0.05	<0.05

Pathogen Data

Microorganisms are ubiquitous in the environment, many of which perform beneficial functions. However, there is a small set of microorganisms, known as pathogens, which are responsible for causing disease. *E. coli* serves as an indicator organism for pathogens with the potential to impact human health.

E. coli is easily transported to streams via storm water runoff and other nonpoint and point source discharges. Once *E. coli* has entered a waterbody, it has the potential to impact human health through the ingestion of excessive bacteria. Because of this, water quality standards for *E. coli* are based on the potential for swimming associated illness in waters with various quantities of *E. coli* organisms present over time. Where *E. coli* is concerned, water quality protection is geared toward those streams where recreation and public water supplies are beneficial uses.

Idaho's Water Quality Standards (IDAPA 58.01.02.521) specify that *E. coli* levels should not exceed an instantaneous measurement of 406 colony forming units (cfu)/100 mL for primary contact recreation (PCR) and 576 cfu/100 mL for secondary contact recreation (SCR) or a monthly geometric mean of 126 cfu/100 mL for both PCR and SCR. However, according to IDAPA 58.01.02.080.03 a single water sample exceeding an E.coli standard does not in itself constitute a violation of water quality standards so additional samples must be taken for the purpose of comparing the results to the geometric mean criteria. An exceedance of the geometric mean criteria constitutes a water quality violation.

In 2004 two exceedances of the instantaneous SCR criteria were observed in Ching Creek and Modoc Creek in July 2004. Further geometric mean sampling will be conducted in 2005 to determine if a violation of water quality criteria exists.

Biological and Other Data

Surface Fines

Since 1993, DEQ has collected water quality data through the Beneficial Use Reconnaissance Program (BURP). The BURP program characterizes water quality based on biological communities and their attributes. Assessing channel materials is an important key to evaluating the biological function and stability of streams. Channel materials consist of surface particles that make up the bed and banks within the bankfull channel. (Rosgen 1996) One method for evaluating the particle size distribution of streambed sediment is the Wolman Pebble Count. BURP crews conduct Wolman Pebble Counts utilizing a set interval method with a minimum of fifty counts per riffle in three riffle habitat units (DEQ 2002). Counts are obtained from the bankfull width on each side. Included are the margins of the streambed, which are not normally under water and may be more depositional than the main channel. A tally is kept of the size categories into which particles fall based on the intermediate axis diameter. From this data, the percentage of particles in set categories can be determined (DEQ 1998).

Sediment fines are defined as materials <6.35 mm in diameter. They are used as an index of sedimentation and beneficial use impairment (DEQ 2002). Studies have shown that many salmonid species prefer particles of this size or greater for spawning success. Studies show that spawning success is diminished when the proportion of finer materials becomes too great. Fine sediment also affects the living space of insects as well as fish (DEQ 2002).

Surface fines and related data are summarized in Appendix A, DEQ BURP monitoring data.

Subsurface Fines

Determining percent composition of surface and depth fine sediment in spawning habitat is used as a complimentary target to track changes in sediment loading over time. Since it is believed that surface fines can easily be swept away by spawning fish, subsurface sediment core samples are more biologically meaningful. Research has shown that subsurface fine sediment composition is important to egg and fry survival, Hall (1986), Reiser and White (1988). McNeil and Ahnell (1964) state that, "size composition of bottom materials greatly influences water quality by affecting rates of flow within spawning beds and ranges of exchange between intragravel and stream water". According to Bjornn, Peery, and Garmann (1998), "Salmonid embryo survival and fry emergence are inversely related to the amount of fine sediment in stream substrates." Fine sediment can decrease the amount of dissolved oxygen (DO) available to developing embryos by impeding flow of water through the substrate and through the oxidation of organic material in fine sediment. Low oxygen availability from excess fine sediment has been associated with smaller and less developed emergent fry."

McNeil Sediment Core samples can describe size composition of bottom materials in identified salmonid spawning locations. McNeil Sediment Core samples are collected by isolating a small area of the stream bottom from the current with an open stainless steel cylinder (12 in). The cylinder is worked to a depth of approximately 4-6 inches into the spawning habitat. Substrate is then removed from the cylinder, washed through a series of ten sieves (63 to .053 mm diameter openings), and then measured via volumetric displacement. Three sediment core samples are obtained for each site and averaged to calculate the percentage of depth fines at the sample location. The percentage of intergravel fines less than 6.35 mm (1/4 in) in diameter is correlated with expected fry survival.

DEQ has a target for volcanic, granitic, and sedimentary watersheds that is less than 28% fine sediment (<6.35 mm diameter) in identifiable spawning habitat. Channel morphology provides flow dynamics that result in fine sediment levels less than 28% in unperturbed conditions. Excessive fine sediment inputs or disturbed channel morphology are indicated by fine sediment compositions above 28%.

In Fall 2003 DEQ collected McNeil depth fine samples in two locations in the Beaver-Camas watershed, Beaver Creek and Camas Creek (Table 21). The Beaver Creek sample site was just above the Miners Creek Confluence on USFS property, above the listed section. Sample results showed that depth fines were just above the target level of 28%, at 28.5% fine materials. The Camas Creek sample site was in the listed reach, below headwaters, sample results yielded a depth fine percentage of 38.4. This is above the target level of 28%.

Table 21. DEQ McNeil Sediment Core sample sites and percentage of depth (4 in) fine sediment.

Stream	Date of data collection	Location	Location Description	% of fine material <6.35 mm
Beaver Creek	10/16/03	N 44.4138° W 112.19732°	At Stoddard Creek exit of I-15	28.5
Camas Creek	10/21/03	N 44.1928° W 111.9817°	upper	38.4

Streambank Assessments

DEQ utilizes streambank erosion inventories (SEI) to assess current erosion conditions within a stream. This method is very useful in identifying load reductions necessary to achieve desired future conditions that are expected to restore beneficial uses to a stream.

DEQ SEIs are conducted in accordance with methods outlined in proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (NRCS 1983). The NRCS technique measures streambank/channel stability, length of active eroding banks, and bank angles. Streambank and channel stability field measurements are used to ascertain the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categorical ratings are summed to a cumulative rating. From the cumulative rating a lateral recession rate is assigned ranging from slight at 0.01 ft/yr. to very severe at 0.5 + ft/yr. An average volume of eroded bank is obtained with the estimated recession rate. By applying a measured or estimated standard bulk density based on composition of streambank material an estimate of tons of sediment from streambank erosion is obtained for comparison to other reaches or for applying a load allocation based on a prescribed reference condition. Appendix F outlines the method for conducting SEIs.

It is assumed that natural background sediment loading rates from bank erosion equate to 80% bank stability as described in Overton and others (1995), where banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally 80% or greater for Rosgen A, B, and C channel types in plutonic, volcanic, metamorphic, and sedimentary geology types. Therefore, an 80% bank stability target based on streambank erosion inventories shall be the target for sediment.

The DEQ conducted a streambank erosion inventory on Camas Creek in late October 2004, approximately two miles downstream of Eighteenmile. As shown in Table 22, the inventoried section of Camas Creek was highly erosive, around 76%. This value is well above the 80% stability target.

Table 22. Camas Creek Erosion Inventory Summary

Reach Location	Total Inventoried (ft)	Erosive (ft)	% Erosive	Ave Bank Height (ft)	Ave Recession Rate (ft/yr)
Camas Creek					
upper	1863	1414	76	5.7	0.61

Proper Functioning Condition

Proper Functioning Condition (PFC) is a technique utilized to determine which stream reaches are at greater risk. Inventories for PFC are conducted in the field where stream characteristics, soils, hydrology, and vegetation, are evaluated. Evaluation results are tallied and the reach is classified as being in proper functioning condition (PFC), functional at risk (FAR), or nonfunctional (NF). A stream classified as PFC is considered healthy. A classification of FAR is healthy but at risk whereas a classification of NF is considered an unhealthy reach.

The BLM has conducted PFC surveys in the subbasin in the years of 1994 and 2004. PFC surveys were conducted on BLM land on Beaver Creek near headwaters (Figure 50) and below the Flat Creek confluence (Figure 49). Figures 49 and 50 illustrate the results of the PFC surveys. The surveys showed that all of the sites near headwaters are not in proper functioning condition and that the lower site was PFC in 2004; demonstrating an upward trend in stream health.

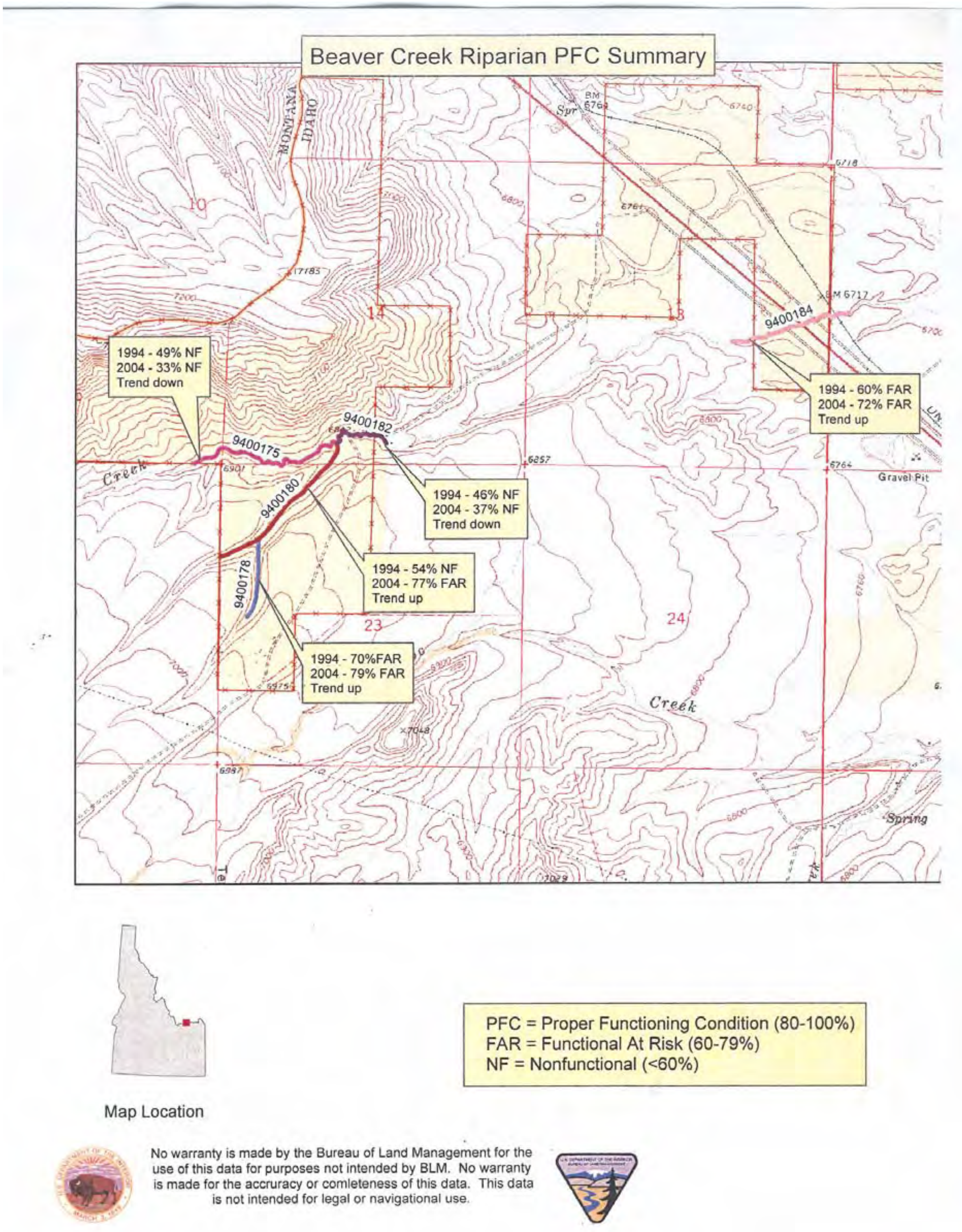


Figure 49. BLM Proper Functioning Conditioning Results for Beaver Creek near Headwaters.

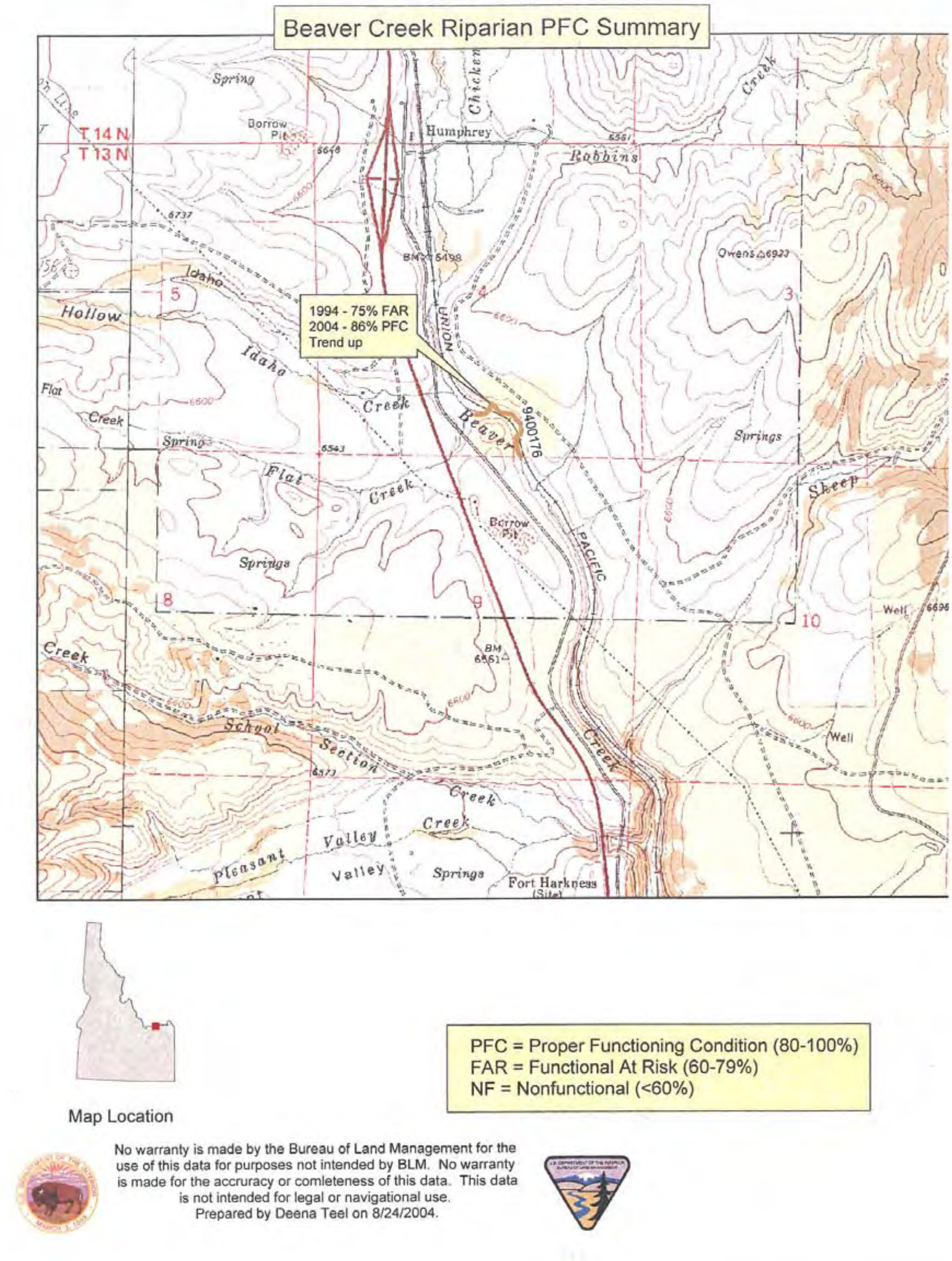


Figure 50. BLM Proper Functioning Conditioning Results for Beaver Creek below Flat Creek Confluence.

Fish Data

Fish distribution and age classes are important for documentation of the existence and status of the fish in the subbasin. DEQ, IDFG, USFS, and BLM collected fish count data (Tables 23-26). Fish data show that brook trout is the most dominant species in the subbasin, the second most abundant is the Yellowstone cutthroat trout, and occasional occurrences of rainbow and brown trout.

From all of the fish data presented below, YCT are located, in the highest abundance in Middle Dry Creek and East Fork Rattlesnake Creek. The low frequency of YCT in the basin is most likely attributed to the introduction of nonnative species (brook trout—BRK), which out-compete the YCT, habitat destruction, and irrigation diversions.

Table 23. DEQ Fish Data Summary

Stream Name	Date Collected	YCT	BRK	RBT	Non-salmonids	comments
Alex Draw	09/17/02		21			70-145 mm
Bear Gulch Creek	08/07/01		13			90-189 mm
Berry Creek	07/21/98		1		(1) sculpin	140-149 mm
Castle Creek	07/22/98		1			130-139 mm
Ching Creek	07/22/98		15			40-219 mm
Ching Creek	08/28/03		58		(10) speckled dace	60-220 mm
Corral Creek	07/15/98	3				90-119 mm
Corral Creek	07/15/98	1				170-179 mm
Cottonwood Creek	07/22/98		8			110-189 mm
Crab Creek	07/08/98	1	1		(2) shiner	140-189 mm
Crooked Creek	08/02/99		5	2		190->300 mm
Dairy Creek	07/09/99		5		(2) sculpin	110-229 mm
Dairy Creek	07/20/98		4	2	(7) sculpin	60-169 mm (BRK), 280-299 mm (RBT)
Dry Creek	07/04/98	5				70-219 mm
E. Camas Creek	07/22/98		14			70-249 mm
E. Camas Creek	08/07/01		53			60-199 mm
E Fk. Rattlesnake	07/15/98	6				70-159 mm
E Modoc Creek	07/21/98	5	26		(6) sculpin	40-209 mm
E Threemile Creek	07/15/98		15			90-199 mm
Horse Creek	07/21/98		4			30-199 mm
Huntley Canyon Creek	08/07/01		6			60-179 mm
Kite Canyon Creek	07/20/98		10			70-229 mm
Little Creek	07/22/98		18			80-199 mm
Long Creek	07/09/99					No Fish
Middle Threemile Creek	07/14/98		5			90-209 mm
Middle Threemile W. Fk	07/14/98		3			100-169 mm
Miners Creek	07/20/98					No Fish
Modoc Creek	07/21/98		8		(18) sculpin	50-229 mm
N. Fk Rattlesnake Creek	07/08/98					No Fish
Pete Creek	07/22/98		17			40-209 mm
Pleasant Valley Creek	07/20/98		5			100-239 mm
Pleasant Valley Creek	07/20/98		15		(5) sculpin	80-149 mm
Pleasant Valley Creek	09/17/02		56		(23) sculpin	60-200 mm

Stream Name	Date Collected	YCT	BRK	RBT	Non-salmonids	comments
Rattlesnake Creek	07/15/98					No Fish
Saw Creek	07/22/98		16			60-219 mm
School Section Creek	07/20/98		4			150-239 mm
Sheep Creek	07/20/98					No Fish
Spring Creek	07/15/98	7	1			90-289 (YCT), 280-289 (BRK)
Spring Creek	07/08/98					Dry
Spring Creek	07/15/65	6				110->429 mm
Steel Creek	07/22/98		41			30-189 mm
Steel Creek	07/17/02		40			35-150 mm
Stoddard Creek	07/20/98		19			30-209 mm
Stump Creek	07/22/98		8			100-139 mm
Threemile Creek	07/15/98					No Fish
Trail Creek	07/08/99		8			100-219 mm
Van Noy Creek	07/20/98					No Fish
West Camas Creek	07/22/98		22			110-249 mm
West Camas Creek	07/08/01		21			60-219 mm
West Camas Creek	08/28/03		16			70-200 mm
West Camas Creek	09/07/04		70		(2) speckled dace	75-195 mm
W Fk Rattlesnake Creek	07/15/98		14			40-269 mm
West Modoc Creek	07/21/98					No Fish
W Threemile Creek	07/14/98		5			80-269 mm
White Pine Canyon Creek	07/20/98		7			40-169 mm

YCT = Yellowstone cutthroat; BRN = brown trout; BRK = brook trout; RBT = rainbow trout; YOY = Young of the Year.

Table 24. IDFG Fish Data Summary

Stream Name	Date Collected	YCT	BRK	BRN	RBT	Non-salmonids	comments
Alex Draw (upper-upper)			26				26-204 mm; 2 pass
Alex Draw (upper)	07/11/02						Dry
Alex Draw (lower)	07/11/02		24				38-192 mm; 1 pass
Calf Creek (upper)	07/12/02						Dry
Calf Creek (lower)	07/12/02						Dry
Ching Creek (upper)	07/13/02						No Fish
Ching Creek (middle)	07/16/02		39				35-200 mm; 2 pass
Ching Creek (lower)	07/15/02					(30) sculpin, (23) dace, (10) sucker	
Cottonwood Creek (middle)	07/12/02		83				35-197 mm; 3 pass; yoy
Cottonwood Creek (upper)	07/12/02		77				33-165 mm; 3 pass
Cottonwood Creek (lower)	07/13/02		66				42-187 mm; 2 pass
Crooked Creek (upper)	07/15/02						No Fish
Crooked Creek (middle)	07/15/02						No Fish
Crooked Creek (lower)	07/15/02						Dry
Middle Dry Creek (upper)	07/13/02						Dry
Middle Dry Creek (middle)	07/13/02						No Fish
Middle Dry Creek (lower)	07/15/02	60					77-252 mm; 2 pass
Middle Dry Creek (lower)	07/13/02						No Fish

Stream Name	Date Collected	YCT	BRK	BRN	RBT	Non-salmonids	comments
E. Fk. Rattlesnake Creek (upper)	07/14/02	81					44-316 mm; 2 pass
E. Fk. Rattlesnake Creek (middle)	07/14/02		6				112-203 mm; 1 pass
E. Fk. Rattlesnake Creek (lower)	07/14/02						Dry
Huntley Canyon Creek (upper)	07/15/02		26				40-223 mm; 2 pass
Huntley Canyon Creek (lower)	07/14/02		14				55-138 mm; 1 pass
Huntley Canyon Creek (middle)	07/14/02		39				42-165 mm; 2 pass
Miners Creek (upper)	06/27/02						No Fish
Miners Creek (middle)	06/27/02						No Fish
Moose Creek (middle)	07/16/02	2	13				45-155 mm (BRK); 150-160 (YCT); 2 pass
Pleasant Valley Creek (upper)	07/11/02		73				32-189 mm; 2 pass; yoy
Pleasant Valley Creek (middle)	07/01/02		83				35-186 mm;1 pass
Pleasant Valley Creek (lower)	07/11/02		36			(3) sculpin	51-227 mm; 2 pass
Rattlesnake Creek	07/14/02						Dry
Spring Creek (upper)	07/14/02						Dry
Spring Creek (middle)	07/14/02						Dry
Spring Creek (lower)	07/14/02						Dry
Spring Creek (lower)	07/16/02		24				54-206 mm; 2 pass
Steel Creek (upper)	07/12/02		37				28-164 mm; 2 pass
Steel Creek (lower)	07/12/02		31				33-160 mm; 2 pass
Threemile Creek (upper)	07/15/02						No Fish
Threemile Creek (lower)	07/13/02						No Fish
Threemile Creek (middle)	07/13/02						No Fish
W. Camas Creek (upper)	07/11/02		32	1			46-192 mm; 1 pass

YCT = Yellowstone cutthroat; BRN = brown trout; BRK = brook trout; RBT = rainbow trout; YOY = Young of the Year

Table 25. BLM Fish Data Summary

<table>
<tr><th>Stream Name</th><th>Date Collected</th><th>YCT</th><th>BRK</th><th>RBT</th><th>Non-salmonids</th><th>comments</th></tr>
<tr><td rowspan="2">Beaver Creek</td><td>08/22/96</td><td></td><td>129</td><td></td><td>(29) sculpin</td><td>72-253 mm</td></tr>
<tr><td colspan="6">55 trout/100 sq meters; 1334 trout/mile (double pass)</td></tr>
<tr><td rowspan="2">Dry Creek</td><td>11/4/98</td><td>116</td><td></td><td></td><td></td><td>55-357 mm</td></tr>
<tr><td colspan="6">YOY Present; 34 YCT/100 sq meters; 1546 YCT/mile (double pass)</td></tr>
<tr><td rowspan="2">Ching Creek</td><td>09/18/00</td><td></td><td>136</td><td></td><td>speckled dace</td><td>68-253 mm</td></tr>
<tr><td colspan="6">31 BRK/100 sq meters (triple pass)</td></tr>
<tr><td rowspan="2">Ching Creek</td><td>09/18/00</td><td></td><td>152</td><td></td><td>speckled dace</td><td>65-245 mm</td></tr>
<tr><td colspan="6">YOY very abundant; 67 BRK/100 sq meters (double pass)</td></tr>
</table>

YCT = Yellowstone cutthroat; BRN = brown trout; BRK = brook trout; RBT = rainbow trout; YOY = Young of the Year

Table 26. USFS Fish Data Summary

Stream Name	Date Collected	YCT	BRK	RBT	BRN	Non-salmonids	comments
Alex Draw Creek	08/19/02		232				50-180 mm
	Three of the fish observed, had shortened operculum. Although stream conditions were less than ideal, there was a substantial population of fish.						
Bear Gulch Creek	09/04/02		404				40-200 mm
	There were no exceptionally large fish caught in Bear Gulch Creek.						
Beaver Creek	09/18/02					124 sculpin	68-253 mm
	Apparently conditions were ideal for sculpin, but less than favorable for any other species of fish. Water flow was very slow and water temperature was warm, (19 degrees Celsius).						
Ching Creek	08/29/02		113				60-200 mm
	Ching Creek supports a population of resident brook trout.						
Dairy Creek	08/26/02		20	7		43 sculpin	70-300 mm
	Given the condition of the stream it was surprising to find anything besides sculpin. In Unit 2, (the beaver dam complex) we caught several fish over 150mm. The rainbow trout we caught were mostly hatchery fish, with the exception of one naturally reproduced rainbow trout. As far as a fishery is concerned, Dairy Creek did hold a substantial amount of fish for the amount of damage the stream has sustained.						
East Fk. Cottonwood Creek	08/26/02						Low Flow
	After a preliminary analysis, we determined not to survey this stream due to the extremely small flows above and below the USFS road, which crosses this stream. It was determined that there was not sufficient habitat for fish in this portion of the stream.						
Pete Creek	08/14/02		140				50-190 mm
	As for aquatic habitat, the overall condition of Pete Creek was poor.						
West Camas Creek	08/06/02		443		7	109 dace, 17 sculpin	Multiple age classes
	The different age classes for the salmonid species (Brown Trout and Brook Trout) are found here suggesting that the habitat types for fish reproduction are present. Undoubtedly, the historic Yellowstone Cutthroat populations found in the West Camas system would have had a large amount of habitat to generate stable populations						
West Fork Cottonwood Creek	08/26/02						
	We shocked three units according to the standard fish distribution data collection protocol, but were unable to capture or observe any fish in the first three units, even while extending Unit 3 to 100m.						

YCT = Yellowstone cutthroat; BRN = brown trout; BRK = brook trout; RBT = rainbow trout; YOY = Young of the Year

Solar Pathfinder

Stream surface shade is an important parameter that controls stream heating derived from solar radiation. Near stream vegetation height, width and density combine to produce shadows that reduce solar loading. Vegetative cover also creates a thermal microclimate that generally maintains cooler air temperatures, higher relative humidity and lower wind speeds along stream corridors. Bank stability is largely a function of near stream vegetation. Specifically, channel morphology is often highly influenced by land cover type and condition by affecting floodplain and instream roughness, contributing coarse woody debris and influencing sedimentation, stream substrate composition and stream bank stability

Solar radiation has the potential to be the largest heat transfer mechanism in a stream system. Human activities can degrade near stream land cover and/or channel morphology, and in turn, decrease shade. It follows that human caused reductions in stream surface shade have the potential to cause significant increases in heat delivery to a stream system. Stream shade levels can also serve as an indicator of near stream land cover and channel morphology condition.

Shade is the amount of solar energy that is obscured or reflected by vegetation or topography above a stream. In contrast, canopy cover is the percent of the sky covered by vegetation or topography. Shade producing features will cast a shadow on the water while canopy cover may not. In order to assess the ability of riparian land cover to shield a stream from solar radiation, two basic characteristics of shade must be addressed: *shade duration* and *shade quality*. The length of time that a stream receives shade can be referred to as *shade duration*. The density of shade that affects the amount of radiation blocked by the shade producing features is referred to as *shade quality*. Effective shade is the amount of potential solar radiation not reaching the stream surface and is a function of *shade duration* and *shade quality*.

The only way to accurately take into account effective shade is to be able to measure the amount of sun blocked by objects as the sun moves across the sky each day throughout the year. The simplest way to do that is to use a solar pathfinder and make a trace of shade producing objects around a stream site on a solar time chart. A solar pathfinder is a table on a tripod holding a solar time chart in the true south direction and covered with a plastic half dome that shows the reflection of objects surrounding it. The solar time chart that is placed on the pathfinder shows the average solar path for each month of the year and amount of time the sun spends at each portion of that path. By visualizing reflected objects in the dome, a tracing is made on the chart of shade producing objects. From the tracing the amount of solar time that the sun is either exposed or blocked by the objects can be determined for each month. Solar time is expressed as a percentage of the entire solar day, thus 100% solar time is the entire length of the sun's path for any given month.

The solar pathfinder was used to measure effective shade in several locations in the Beaver-Camas Subbsin in 2004 (Figures 51-61). Tracings were taken in accordance with the method manual provided by the manufacturer (Solar Pathfinder 2002) at systematically placed sites in the stream. At each site the pathfinder was placed in the center of the stream approximately one foot above the water. The pathfinder was oriented to true south by correcting for a 17° declination. Tracings were made recording all objects providing shade including deciduous vegetation and topographic features. Data from the sites were averaged to provide average estimates of solar time exposed and solar time blocked for each month from there, annual and summer effective shade averages were tabulated for specific groups of sites were stream conditions were homogeneous. Table 27 provides a listing of the percent annual and summer (April – September) effective shade for groups of stream sites in watershed. Refer to Appendix H for a more detailed description on solar pathfinder methodology.

Table 27. Percent annual and summer effective shade for stream sites in the Beaver-Camas Subbasin

Creek and Site Numbers	Ave Annual Shade (%)	Ave Annual Open (%)	Ave Summer Shade (%)	Ave Summer Open (%)
Beaver Creek (B1-B3)	64	36	48	52
Beaver Creek (B4-B8)	46	54	24	76
Beaver Creek (B9-B16)	44	56	18	82
Beaver Creek (B17-B25)	24	77	7	93
Beaver Creek (B26-B33)	24	76	11	89
Beaver Creek (B34-B38)	13	88	7	93
Camas Creek (C1-C8)	9	91	3	97
Camas Creek (C9-C13)	4	96	5	96
Camas Creek (C14-C23)	11	89	7	96
Dairy Creek (D1-D5)	64	36	47	53
Miners Creek (MC1-MC5)	61	39	46	54
Modoc Creek (M1-M5)	48	52	41	59
Threemile Creek (T1-T5)	62	38	57	44
Stoddard Creek (S1-S10)	53	47	46	54

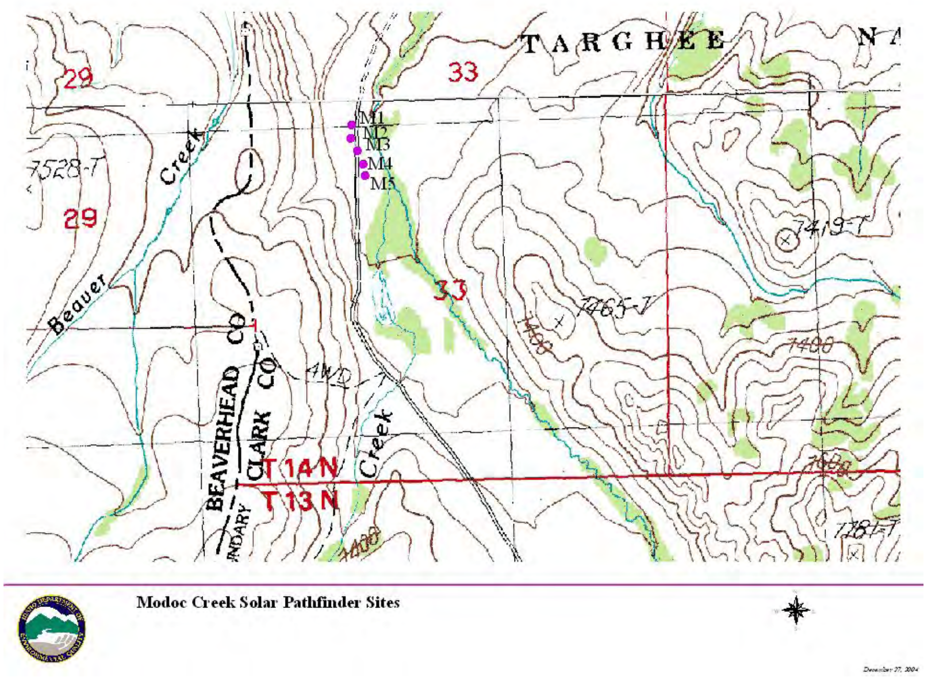


Figure 51. Modoc Creek Solar Pathfinder Sites.

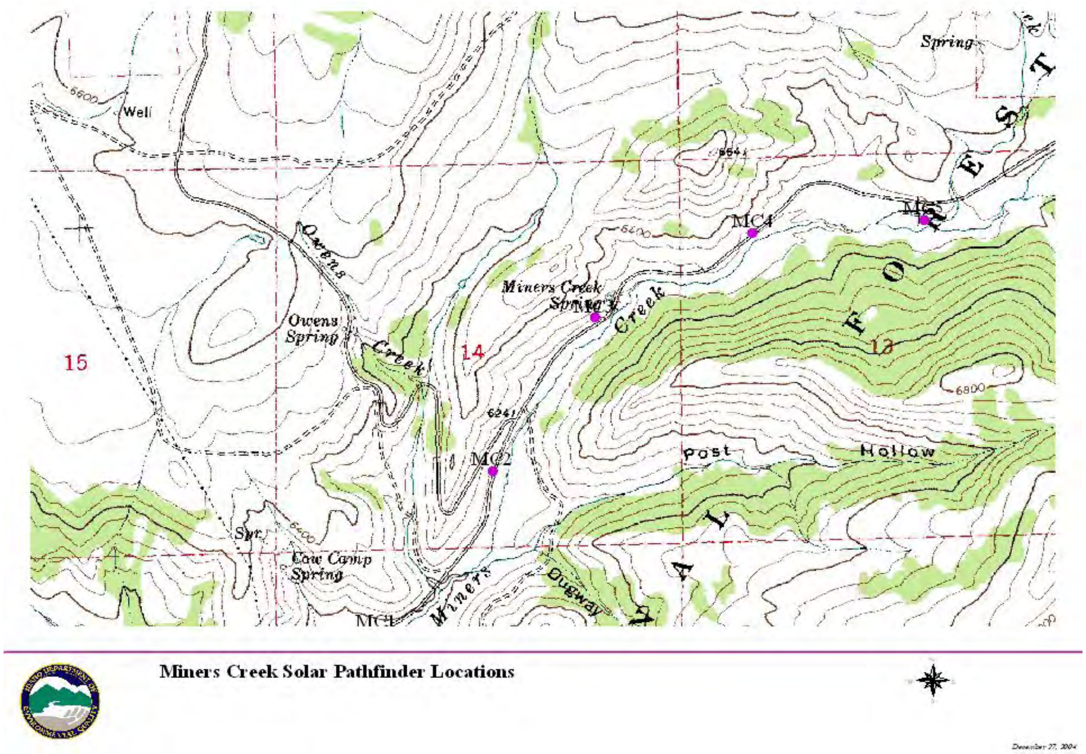


Figure 52. Miners Creek Solar Pathfinder Sites.

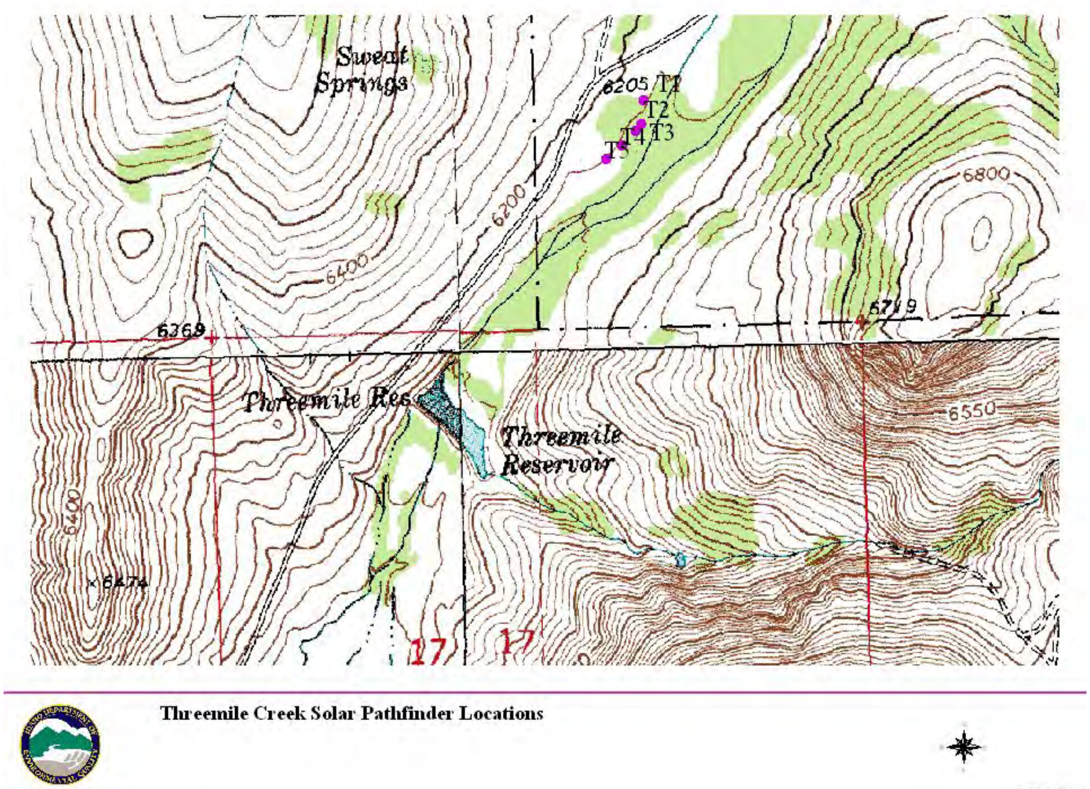


Figure 53. Threemile Creek Solar Pathfinder Sites.

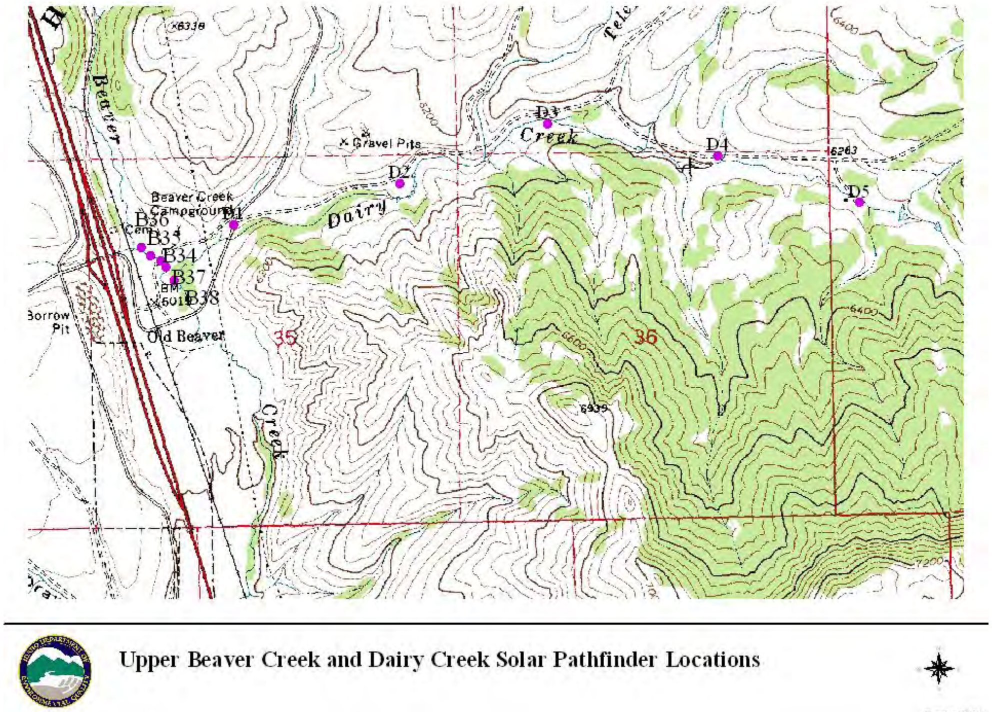


Figure 54. Upper Beaver, and Dairy Creek Solar Pathfinder Sites.

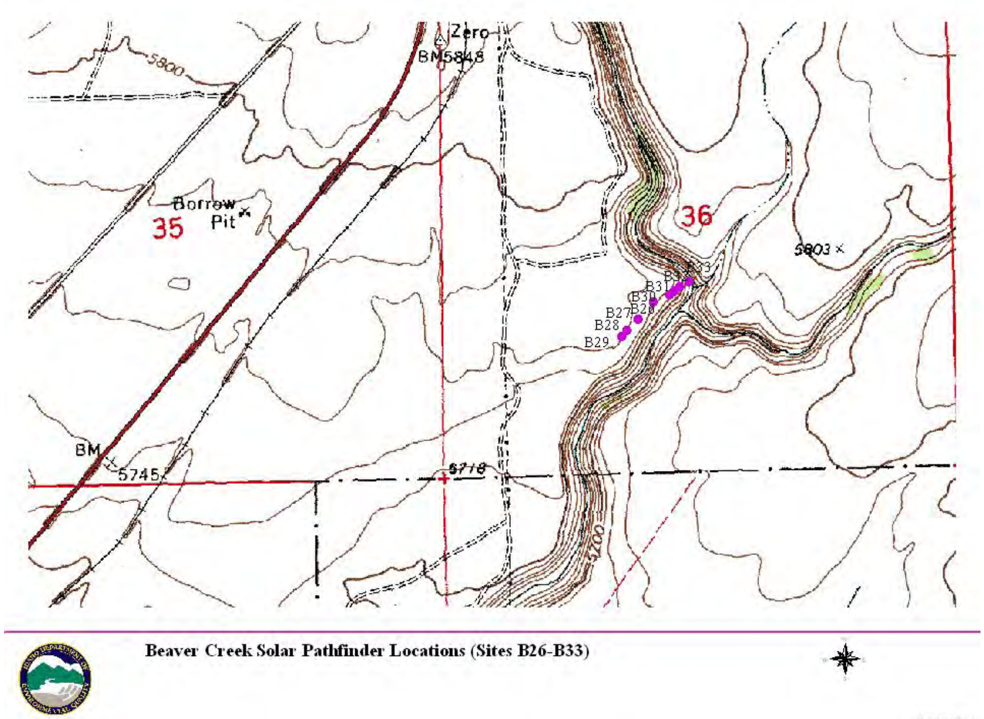


Figure 55. Beaver Creek Solar Pathfinder Sites (B26-B33).

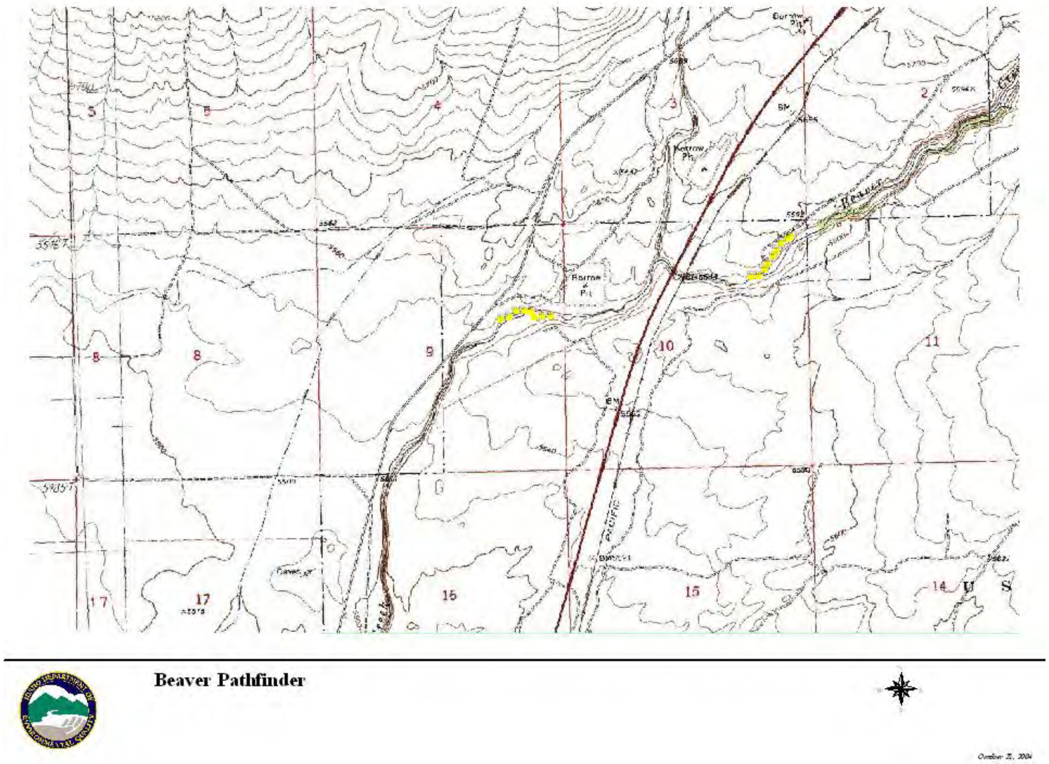


Figure 56. Beaver Creek Solar Pathfinder Sites (B26-33).

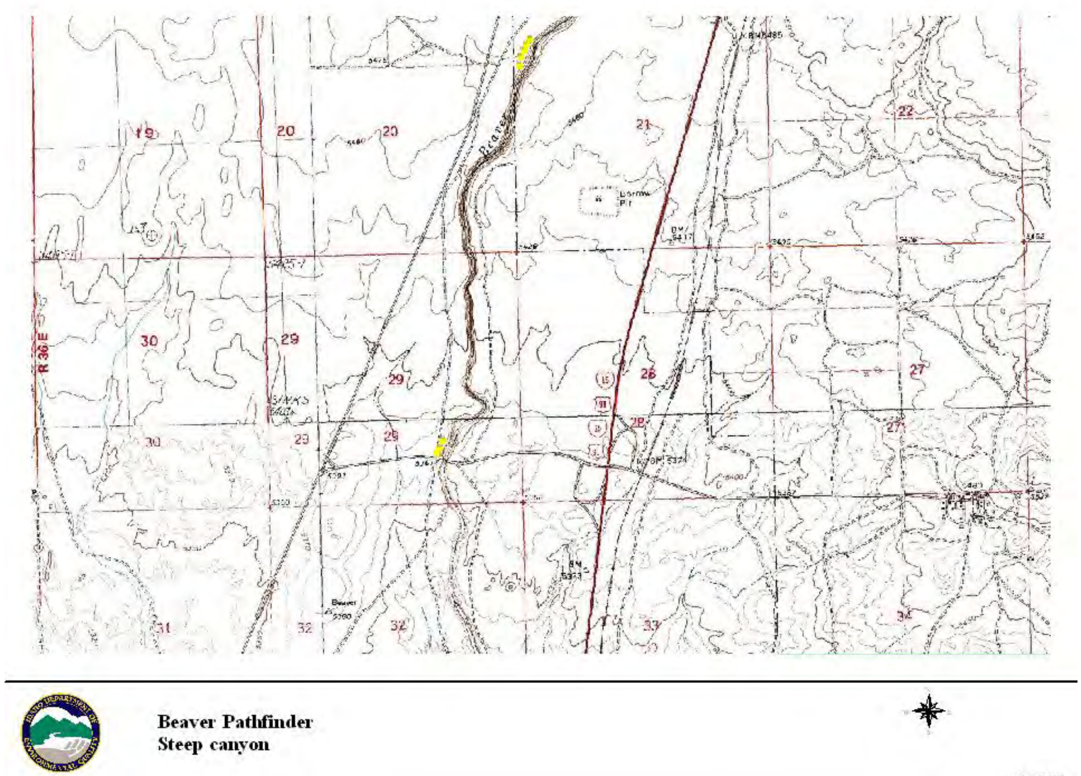


Figure 57. Beaver Creek Solar Pathfinder Sites (B9-25).

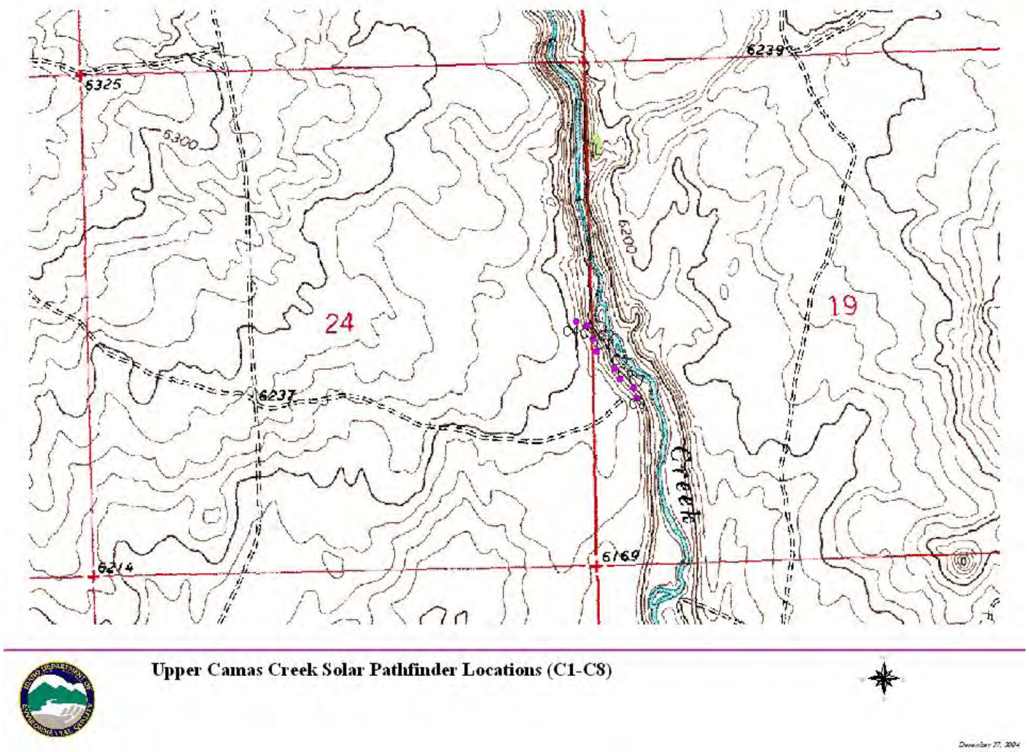


Figure 58. Camas Creek Solar Pathfinder Sites (C1-C8).

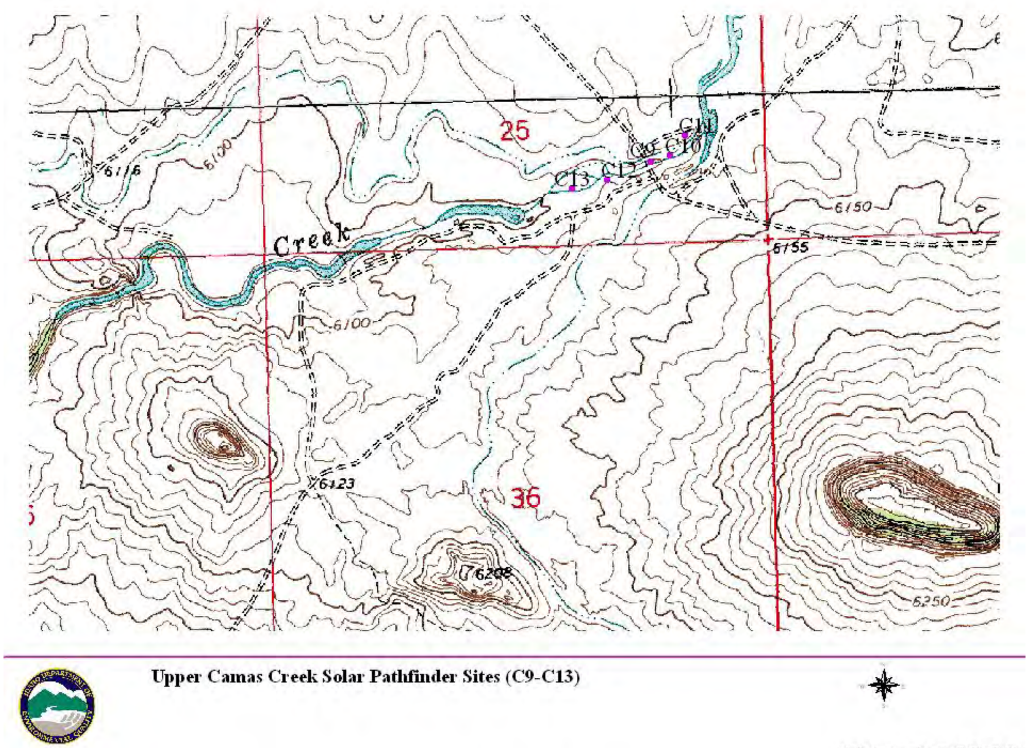


Figure 59. Camas Creek Solar Pathfinder Sites (C9-C13).

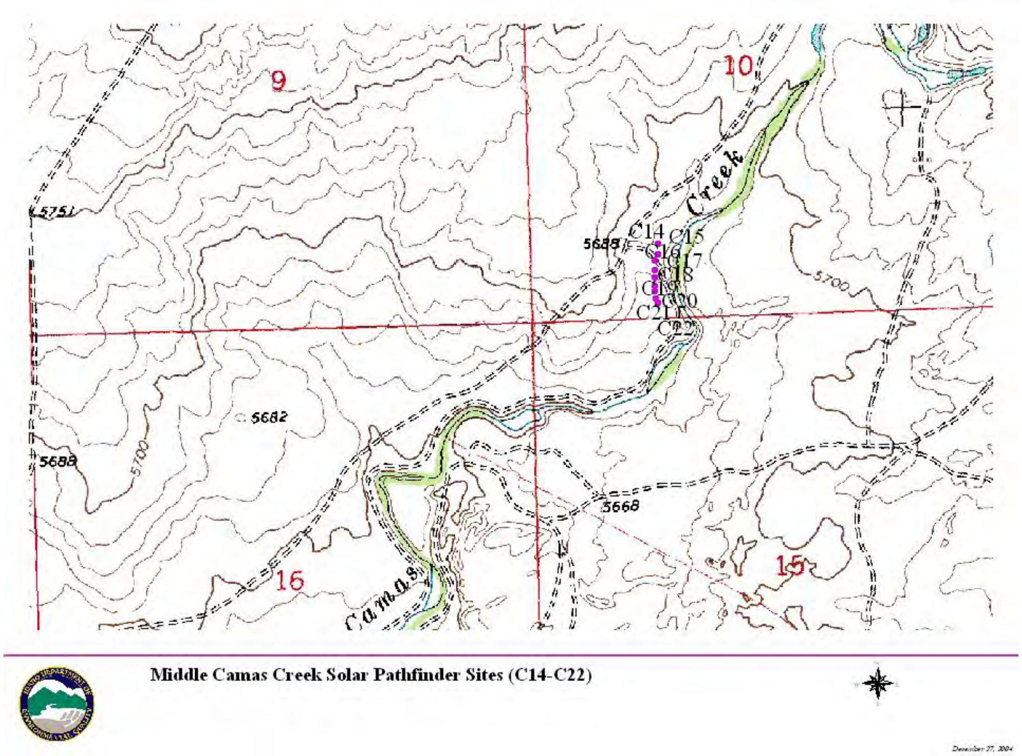


Figure 60. Camas Creek Solar Pathfinder Sites (C14-C22).

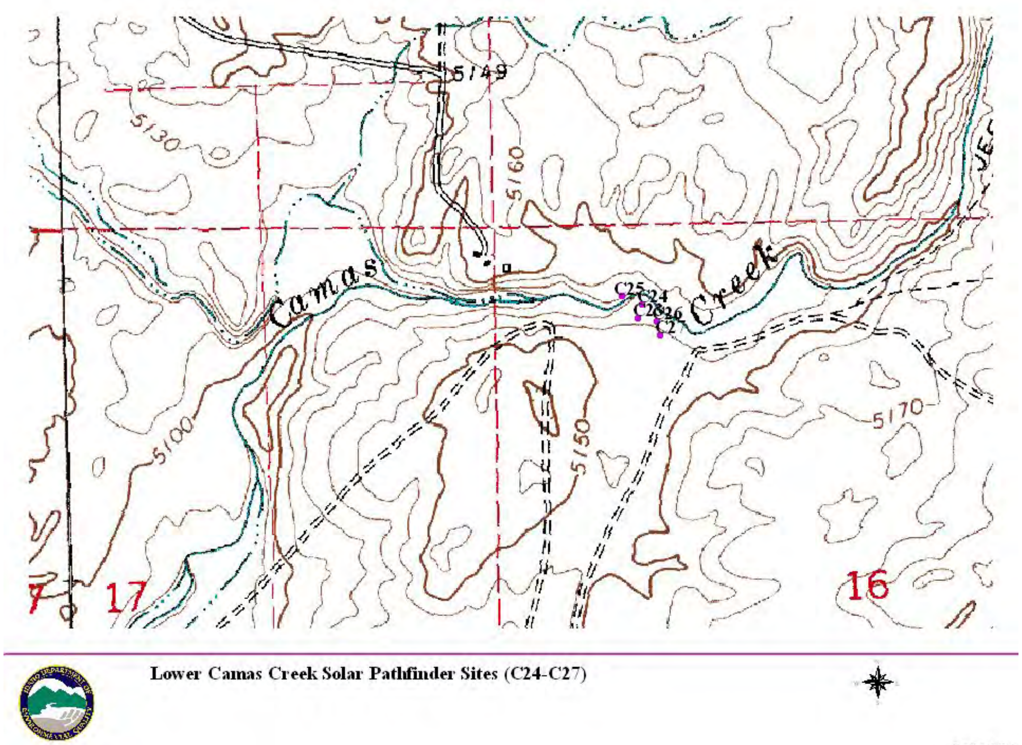


Figure 61. Camas Creek Solar Pathfinder Sites (C24-C27).

Status of Beneficial Uses

The data presented in this section confirms that the beneficial uses for salmonid spawning (SS) and cold water aquatic life (CWAL) for one of the listed stream segments in the Beaver-Camas Subbasin are not fully supported. The upper section of Camas Creek and one-quarter (approximate) of the section of Beaver Creek between Spencer and Dubois, are the only two listed stretches of water that have the capacity to support beneficial uses. The data presented show that the part of the listed section of Beaver Creek (below Spencer), Cow Creek, and the lower half of Camas Creek are not perennial streams, by both natural and anthropogenic dewatering of the channel. The maintenance of a fishery in dewatered streams is limited therefore, beneficial uses cannot be supported until flows are returned to the stream, where it is anthropogenic dewatering occurs.

Conclusions

Beaver Creek from Spencer to Dubois is listed for flow alteration, habitat alteration, nutrients, sediment, and temperature. The lower half (below I-15 exit 172) of this listed reach is naturally dewatered and does not have a reasonable potential to support beneficial uses. A TMDL will not be developed for Beaver Creek, below I-15 exit 172. Above the intermittent portion of Beaver Creek, a temperature TMDL will be developed since stream temperature data at the Spencer site show that the temperature criteria for SS and CWAL are not met. This section of Beaver Creek, listed for sediment as well, is completely confined in a basalt canyon and streambank erosion is not contributing to overall sediment loading to impair beneficial uses. Additionally, depth fine data collected above the listed reach is at the target level. Nutrient data collected in Spencer is below EPA suggested criteria and no nuisance algal growths are present that would impair beneficial use support. Therefore, a nutrient TMDL is not necessary for this particular section of Beaver Creek. Beaver Creek will be de-listed for nutrients.

Beaver Creek from Dubois to Camas Creek is listed for the same pollutants as the upper portion of Beaver Creek. As shown by the flow data presented in section 2.3, Beaver Creek below Dubois only receives flow about one week out of the year. A TMDL will not be developed for this section of Beaver Creek since it is intermittent.

The upper listed section of Camas Creek (Spring Creek to Hwy 91) is listed for flow alteration, habitat alteration, nutrients, sediment, and temperature. As with Beaver Creek there is a point (T9N, R37E, section 16/N44.19270°, W-111.98284°) in this reach where the stream is flow altered (anthropogenic and natural). From that point down a TMDL will not be developed. From that point upstream, temperature and sediment TMDLs will be developed since stream temperature data exceeds the criteria (CWAL and SS) and depth fine samples are above the 28% target and bank erosion is evident and sediment deposition in spawning habitat is impairing beneficial uses. A nutrient TMDL will not be written for this stream because water column samples are below the EPA suggested criteria and deleterious levels of macrophyte growth are not present in the stream. This section of Camas Creek will be proposed for de-listing for nutrient, sediment, temperature and re-listed as flow altered.

Cow Creek is listed with an unknown pollutant. Cow Creek is an ephemeral stream and therefore a TMDL will not be developed for Cow Creek. Cow Creek will re-listed as flow altered.

Nitrate (NO_3) + Nitrite (NO_2) Nitrogen concentrations were above the EPA suggested criteria on E. Fk. Rattlesnake Creek however, visible slime growth or other nuisance aquatic growth impairing designated beneficial uses were absent. A nutrient TMDL is not necessary for E. Fk. Rattlesnake Creek since Idaho's narrative water quality criteria for nutrients are met.

Stream temperature data was presented for several streams in the Beaver-Camas watershed. As stated above, TMDLs will be written for the listed areas of Beaver and Camas Creeks where flows are perennial. In addition to Beaver and Camas Creeks, temperature data was provided for eight additional streams; Stoddard, Miners, Dairy, Modoc, Crooked, Threemile, West Fork Rattlesnake, and East and West Camas Creeks. In four of the locations, Stoddard, Miners, Rattlesnake and Crooked Creeks the stream is flow altered (anthropogenic or natural) and flows were intermittent therefore a TMDL will not be written for those streams where there were documented exceedances.

Major temperature exceedances (>10%) were documented Dairy, Modoc, and East and West Camas Creeks (perennial). Temperature TMDLs will be written for all of these streams. In addition, stream temperature data is available for Beaver Creek above the listed reach and temperature exceedances were documented therefore, the Beaver Creek temperature TMDL will extend above the listed reach to headwaters.

2.5 Data Gaps

The hydrology of the Beaver-Camas subbasin is a complex system of naturally loosing reaches and diversions and canal systems. In many cases, existing stream conditions diverge from those of natural conditions due to land management activities such as diversions and riparian grazing. The upper sections of the watershed tend to show the most promise for beneficial use support from both a flow and stream condition perspective.

Despite hydrologic limitations, some biological and water quality data was collected in the subbasin and it was available for analysis. However, subsurface fine sediment data was limited and it is extremely important in assessing sediment impacts on salmonid spawning habitat.

Since sedimentation appears to be the largest water quality issue in the basin, streambank erosion inventories should also be conducted during the implementation phase of the TMDLs to provide for a more precise and accurate description of water quality in the Beaver-Camas drainage.

3. Subbasin Assessment–Pollutant Source Inventory

Riparian destruction initiates the rise in stream temperatures and sedimentation to the streams in the Beaver-Camas Subbasin. As riparian vegetation is removed, the shade provided by the vegetation decreases and streambanks begin to erode. The reduction in shade further decreases the stability of streambanks and increases the thermal loading to the stream. This type of pollution occurs over a wide area and is considered nonpoint source pollution.

3.1 Sources of Pollutants of Concern

Point Sources

There are no Superfund or Resource Conservation Recovery Act (RCRA) sites in the Beaver-Camas Subbasin. There are no national pollution discharge elimination system (NPDES) permitted point sources, nor are there any potentially unpermitted point sources in this area. Since there are no known point sources, no waste load allocations (WLA) will be developed for point sources.

Nonpoint Sources

The primary sources of nonpoint source pollution to streams in the Beaver-Camas Subbasin are sediment from streambank erosion and solar radiation from riparian habitat destruction. As near-stream vegetation is degraded, overall stream cooling is reduced. There is a direct relationship between streambank erosion and loss of riparian vegetation. As stabilizing vegetation is removed, streambanks become unstable and bank erosion follows. As streambank erosion progresses, depositional features form in the channel that redirect current and further reduce bank stability. This process continues until the stream forms a new flood plain and deposition forms new streambanks that become colonized with stabilizing vegetation. This process can take many years to play out once channel alteration begins. As near stream vegetation is degraded overall stream cooling is reduced. In addition, channel morphology is highly influenced by land cover by affecting the floodplain and instream roughness, which, in turn, influences bank stability, stream substrate composition, and sedimentation.

Land use, as previously discussed, is primarily agricultural adjacent to streams impaired by temperature and sediment. The agricultural use that has the greatest effect on streambank stability is grazing. Grazing occurs throughout the subbasin in riparian areas.

Other sources of nonpoint source sediment pollution can include roads and erosion from cultivated fields.

Pollutant Transport

The bulk of the sediment comes from streambank erosion during several weeks of high spring flow. However, in some instances, the transport and delivery of pollutants within and between perennial streams is limited because of the lack of connectivity between streams. Some streams infiltrate, or are diverted before they have confluence with other surface waters, even during snowmelt. Groundwater transport of pollutants has not been shown to be a significant conduit of pollutants

As riparian vegetation is removed from the stream, the stream cooling capabilities of that vegetation is reduced and solar radiation increases. Stream temperatures are cumulative where the conditions at a site contribute to heating of already heated water.

3.2 Data Gaps

Point Sources

There are no point sources in this subbasin.

Nonpoint Sources

Additional data collection should include more quantitative trend monitoring related to rangeland and riparian interface areas on perennial streams. The primary fishery concern, due to the isolation of perennial streams and the lack of connectivity with other surface waters, would be the impact from any particular catastrophic event on the streams supporting a Yellowstone cutthroat trout population. The greatest risk would be from sediment inputs related to extreme hydrologic events and the cumulative impacts from streambank erosion. Trend data related to grazing impacts is also lacking. Additionally, data related to trends in geomorphology and riparian vegetation physical structure would be useful to determining long term risks associated with grazing.

4. Subbasin Assessment – Summary of Past and Present Pollution Control Efforts

To our knowledge, there have been no public pollution control efforts in the Beaver-Camas Subbasin. We are aware of one private pollution control effort in the drainage consisting of one mile of electric riparian fencing on West Camas Creek (T13N, R38E, section 25)

5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. The load capacity must be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 In-stream Water Quality Targets

The goal of the TMDL is to restore "full support of designated beneficial uses" on all 303(d) listed streams within the Beaver-Camas Subbasin. Water quality pollutants of concern for which a TMDL will be written are sediment and temperature. A TMDL will not be written for streams listed with flow alteration (natural and anthropogenic) as a pollutant since the EPA does not believe that flow (or lack of flow) is a pollutant as defined by CWA Section 502(6). The objective of this TMDL is to establish a declining trend in pollutant loading and to regularly monitor the pollutant load and beneficial use support. Pollutant reductions may be attained, in part, by improving canopy cover, vegetative buffers, and decreasing stream width/depth ratios along streambanks.

For temperature TMDLs a potential natural vegetation (PNV) approach will be utilized. It is assumed that shade is maximized and solar loading is minimized to a stream under PNV. Thus stream temperatures are at their lowest levels under PNV. The PNV approach is described below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in this section.

Potential Natural Vegetation for Temperature TMDLs

There are a several important contributors of heat to a stream including ground water temperature, air temperature and direct solar radiation. Of these, direct solar radiation is the source of heat that is easiest to control or manipulate. The parameter that affects or controls the amount of solar radiation hitting a stream throughout its length is shade. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Again, the amount of shade provided by objects other than vegetation is not easy to control or manipulate. This leaves vegetation as the most likely source of change in solar radiation hitting a stream.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. We can measure the amount of shade that a stream enjoys in a number of ways. Effective shade, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or estimated visually either on site or on aerial photography. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is that intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in anyway. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides the most shade and the least achievable solar loading to the stream. Anything less than PNV is allowing the stream to heat up from excess solar inputs. We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what can be done to decrease solar gain.

Existing shade or cover will be estimated for entire lengths of streams from visual observations of aerial photos. These estimates can be field verified by measuring shade with solar pathfinders or cover with densiometers at randomly or systematically located points along the stream (see below for methodology). PNV will be determined from existing shade curves developed for similar vegetation communities. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. Existing and PNV shade can be converted to solar load from data collected on flat plate collectors at the nearest weather station collecting these data. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards. Existing shade cannot be greater than PNV shade, thus existing loads cannot be less than PNV loads. PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are considered to be the lowest achievable temperatures (so long as there are no point sources or any other anthropogenic sources of heat in the watershed).

Pathfinder Methodology

The solar pathfinder is a device that allows one to trace the outline of shade producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. At each sampling location the solar pathfinder was placed in the middle of the stream about one foot above the water. We followed the manufacturer's instructions (orient to true south and level) for taking traces. Systematic sampling was easiest to accomplish and still not bias the location of sampling. We started at a unique location such as 100 m from a bridge or fence line and then proceeded upstream or downstream stopping to take additional traces at fixed intervals (e.g. every 100m, every half-mile, every degree change on a GPS, every 0.5 mile change on an odometer, etc.).

Aerial Photo Interpretation

Canopy coverage estimates are provided for natural breaks in vegetation density, marked out on a 1:100K hydrography. Each interval was assigned a single value representing the bottom of a 10% canopy coverage class as described below (*adapted from the CWE process, IDL, 2000*):

Cover class	Typical vegetation type
0 = 0 – 9% cover	agricultural (ag) land, denuded areas
10 = 10 –19%	ag land, meadows, open areas, clearcuts

20 = 20 – 29%	ag land, meadows, open areas, clearcuts
30 = 30 – 39%	ag land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 –100%	forested

The visual estimates of cover were field verified with a solar pathfinder. The pathfinder measures effective shade and it is also takes into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The estimate of cover made visually from an aerial photo does not take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that cover and shade measurements taken by densiometers and pathfinders, respectively are remarkably similar (OWEB, no date).

Aerial photo estimates likely underestimate spots that have higher cover and overestimate spots that have lower cover, when looking at the entire stream, these discrepancies balance themselves out. (Shumar 2005)

Design Conditions

Sediment

To quantify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak and base flow conditions. Annual erosion and sediment delivery are functions of a climate where wet water years typically produce the highest sediment loads. Additionally, the annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months.

Temperature

Solar loading from direct solar radiation leads to warming of stream temperatures; channel geometry and near stream land cover influence solar loading. Related facts about solar loading and stream temperature include the following:

- Stream widening and limited riparian shading will ultimately result in increased stream temperatures.
- There is a high degree of seasonality to solar heating; as ambient air temperatures increase in the spring and summer, the need to limit solar loading also increases.

- Canopy shading maintains cooler air temperatures in and around the stream and limits the quantity of direct sunlight to the water during the summer months when radiant energy is at its greatest.
- Solar loading is tabulated and analyzed during the warmer months (April-September) of the year, since this is the critical time period for beneficial use support (CWAL and SS) and the time when the most significant solar loading to the stream is expected to occur.

The temperature critical time periods for salmonid spawning in the Beaver-Camas Subbasin are identified as May 1st through June 30th (Schrader 2003) for spring spawners; and September 15th through November 15th for fall spawners.

Likely vegetative species identified for the established expected effective ranges are generalizations based on Bitter Restoration's *Classification and Management of USDI Bureau of Land Management's Riparian and Wetland Sites in Eastern and Southern Idaho* (Hansen and Hall 2002).

Beaver Creek

Beaver Creek flows from north to south with headwaters originating near the Montana border, at the continental divide, and ending at the confluence with Camas Creek. Beaver Creek is the second largest tributary in the subbasin. Geologically, upper Beaver Creek is dominated by alluvium with deposits of felsic pyroclast and conglomerate. The lower half of Beaver Creek, below Spencer, is dominated by mafic volcanic flow. The stream is dominated by alluvial valley stream reaches in the upper half and volcanic basalt canyons in the lower half.

Dominant natural vegetation on Beaver Creek above 5800 feet is likely to be bebb willow (*Salix bebbiana*), and geyer willow (*Salix geyeriana*). Below 5800 feet, dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)* are the dominant vegetation types.

Camas Creek

The headwaters for Camas Creek are where, West Camas Creek, East Camas Creek, Spring Creek, and Crooked Creek converge, near Eighteemile. The drainage from source tributaries is voluminous, with a spring peak just following snowmelt. During the peak flow period, flow is continuous from headwaters to Mud Lake. However, following peak flow, Camas is considered a loosing reach and flows naturally subside. Considerable dewatering for agricultural purposes also contribute to the dewatering of Camas Creek. Hydrologically, Camas Creek is an intermittent stream with limited connectivity to Mud Lake.

Physically, Camas Creek from headwaters to mouth, is dominated by a mafic volcanic flow lithology. The stream channel, where perennial flows exist, is characterized by a system of basalt canyon/basalt streambed transport reaches alternated by substrate dominated depositional reaches. The sediment dominated depositional reaches are the most susceptible to streambank erosion due to the moderately sloped stream channel and a lack of natural bank armoring provided by the natural basalt lithology. Annual sediment delivery was calculated based on streambank erosion in the susceptible substrate dominated reaches of the stream.

Natural vegetation on upper Camas Creek, 5600-6300 ft in elevation, is likely dominated by bebb willow (*Salix bebbiana*), and geyer willow (*Salix geyeriana*) and natural vegetation below 5600 feet, on middle Camas Creek, is dominated by bebb willow (*Salix bebbiana*) and coyote willow (*Salix exigua)*.

Dairy Creek

Dairy Creek is a small tributary of Beaver Creek that flows from east to west. The lithology of Dairy Creek is a combination of alluvium in the upper reaches and conglomerate in the lower reaches. Generally, soils in the Dairy Creek watershed are gravely loam, deep and very well drained.

Upper Dairy Creek is forested and natural vegetation types are douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*. Below the forested area, approximately 6500 feet, bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*) dominate.

Modoc Creek

Modoc Creek, originates in the northwestern corner of the watershed, headwaters for Modoc Creek are West, Middle, and East Modoc Creek and the mouth is at the confluence with Beaver Creek. Soils in West, Middle, East and mainstem Modoc Creek are very deep, well drained gravely loam to silty loam, formed from rhyolitic tuff and loess on mountain sides and foothills. Natural vegetation types for all of Modoc Creek are presumed to be drummond willow *(Salix drummondiana*), bebb willow (*Salix bebbiana*), and coyote willow (*Salix exigua)* .

Threemile Creek

West, East, and Middle Threemile Creeks are located in the upper middle section of the Beaver-Camas watershed where the dominant lithology is alluvial. Mainstem Threemile is located further south where dominant lithology transitions from alluvium to basalt.

Vegetation in upper East and Middle Threemile Creek is forested with the dominant vegetation types douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta).* At lower elevations, where the forestland ends, dominant vegetation transitions to a quaking aspen (*Populus tremuloides*)/red-osier dogwood (*cornus stolonifera*) community. Natural vegetation on West and Mainstem Treemile Creek consists of bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*).

West Camas Creek

West Camas Creek, located in the eastern half of the watershed, is a tributary of Camas Creek. West Camas Creek is dominated by stony to gravely loam, well drained soils originating from weathered rhyolite and closely related bedrock.

Vegetation in the watershed transitions from a douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)* community in the upper elevations to an aspen (*Populus* *tremuloides*)/red-osier dogwood (*cornus stolonifera*) community in mid elevations and finally transitioning to a bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)* community where West Camas and East Camas Creek converge to form Camas Creek.

East Camas Creek

Topography and vegetation on East Camas Creek are very similar to that of West Camas Creek. Vegetation consists of a conifer community in the upper elevations to a deciduous aspen community in the transition zone and a willow community in the lower elevations.

Target Selection

TMDL target selection addresses temperature and sediment values, which are discussed in the following:

Sediment

Target selection of sediment is dependent on existing narrative criteria of IDAPA 58.01.02.200.08.

Sediment targets for this subbasin are based on streambank erosion quantitative allocations in tons/mile/year. The reduction in streambank erosion prescribed in this TMDL is directly linked to the improvement of riparian vegetation density to armor streambanks thereby reducing lateral recession, trapping sediment. and reducing stream energy, which in turn reduces stream erosivity and instream sediment loading. It is assumed that by reducing chronic sediment, there will be a decrease in subsurface fine sediment that will ultimately improve the status of beneficial uses.

It is assumed that natural background sediment loading rates from bank erosion equate to 80% bank stability as described in Overton et al. (1995), where banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally 80% or greater for Rosgen A, B, and C channel types in plutonic, volcanic, metamorphic, and sedimentary geology types. Therefore, an 80% bank stability target based on streambank erosion inventories shall be the target for sediment.

Unnatural streambed sediment size composition can directly impair spawning success, egg survival to emergence, rearing habitat, and fish escapement from stream. It is necessary to reduce the component of subsurface fine sediment less than 6.35 mm to below 28% of total subsurface sediment. This sediment particle size parameter should be considered as part of target monitoring to evaluate any significant shift in subsurface fine particle frequency distribution.

Temperature

It is known that solar load is affected by the amount of vegetation and other objects blocking direct sunlight from reaching the stream, and it is presumed that direct solar radiation is the most likely source of elevated stream temperatures in the Beaver-Camas subbasin. The target values for this TMDL are based on the percentage of effective shade at PNV. Natural stream width, channel type, and type of riparian community present are important factors to evaluate when determining the effective shade potential around a specific reach of stream. To determine the target values for streams in the Beaver-Camas subbasin, effective shade curves from the *Alvord Lake Subbasin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)* (Oregon DEQ 2003), *Potential Near-Stream land Cover in the Willamette Basin for Temperature Total Maximum Daily Loads* (Oregon DEQ 2004), *Walla Walla River Subbasin Stream Temperature Total Maximum Daily Load and Water Quality Management Plan* (Oregon DEQ 2004), and *South Fork Clearwater Total Maximum Daily* Loads (IDEQ 2004) were evaluated. These TMDLs had previously used vegetation community modeling to produce these shade curves. For Beaver Creek, Camas Creek, Dairy Creek, Modoc Creek, East Camas Creek, Threemile Creek, and West Camas Creek the most similar vegetation types were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves available (Tables 28-34). Alvord Lake vegetation is predominantly high desert/mountain valley shrub communities. The SF Clearwater VRU12/VRU16 plant communities were heavily dominated by grasses. Willamette Basin and Walla Walla River areas have a greater percentage of trees in their communities. The combination of all four of these community types balances out the variety of communities likely to be encountered in the Beaver/Camas subbasin.

Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type looses its ability to shade wider and wider streams. Because vegetative community and stream width determine the percent of expected shade, each of the streams were separated into different reaches based on varying stream width and vegetative community. The stream reach, type of vegetative community, reference shade curves, and the established shade target are shown in Tables 28-34.

As stated above, bankfull width is an essential parameter when utilizing effective shade curves for the determination of potential natural vegetation. Limited field measurements of bankfull width are available so, this parameter must be estimated from available information. Average values for bankfull channel width as a function of drainage area has been established for six regions, one of which is the Upper Salmon River (Rosgen 1996). Through the utilization of the Upper Salmon River regional curve, bankfull width was determined for each of the reaches listed in Tables 28-34. This was accomplished by calculating the upstream drainage area (DA) at the lower end of each of the stream reaches. Drainage area values were then utilized to determine average bankfull width for each stream reach. Derived bankfull width values were also compared to field measurements taken by BURP crews, showing that bankfull widths derived from the regional curve coincided with field measurements.

The utilization of the regional curve to determine bankfull width, rather than direct field measurements, serves to show that established target values were based on what expected (natural) bankfull width values are. As stated earlier, stream widening is a significant morphological change that takes place in riverine systems impaired by riparian grazing. Since morphological changes could lead to field measurements that misrepresent what undisturbed stream widths may be, bankfull width based on drainage area is a more accurate representation of what natural stream widths are.

Appendix J provides a more detailed delineation of each stream reach and the established target value.

Table 28. Beaver Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Modoc Creek to first canyon	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	7	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	52
			Walla Walla TMDL – Deciduous Zone (Figure 8)	85
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	25
				Target Average = 58
First Canyon (narrow and deep)	Canyon, bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*	7	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	48
			Walla Walla TMDL – Deciduous Zone (Figure 8)	78
			Willamette Basin TMDL – Qg1 (Appendix C)	66
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	21
Target Average = 53 however the steep walled canyon does not support vegetation so target set at **50** for maximum topographic shading				
Upper Canyon to below Spencer	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*	8	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	38
			Walla Walla TMDL – Deciduous Zone (Figure 8)	80
			Willamette Basin TMDL – Qg1 (Appendix C)	55
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	18
				Target Average = 48
Canyon Below Spencer	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	11	Same As First Canyon	
				Target Average =50
Shallow Canyon	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	14	Alvord Lake TMDL - Willow Community (Figure 2.40)	19
			Willamette Basin TMDL – Qg1 (Appendix C)	51
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	17
				Target Average = 29
Lower Beaver Below Canyon	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	15	Same as first canyon	
				Target Average = 50

Table 29. Camas Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper Camas Creek (eighteenmile	bebb willow (*Salix bebbiana*) and geyer willow (*Salix*	15	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	25
			Willamet Basin TMDL – Qg1 (Appendix C)	49

to first canyon)	*geyeriana)*		South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	11
				Target Average = 28
Canyon Areas	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	15	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	25
			Willamette Basin TMDL – Qg1 (Appendix C)	49
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	11
				Target = 28
Below Canyon to dry	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	15	Alvord Lake TMDL - Willow Community (Figure 2.40)	17
			Willamette Basin TMDL – Qg1 (Appendix C)	49
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	11
				Target Average = 26

Table 30. Dairy Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper Dairy Creek (headwaters to forest boundary)	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	2	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	85
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	90
			Willamette Basin TMDL – Qalf (Appendix C)	85
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	92
				Target Average = 88
Lower Dairy Creek (forest boundary to mouth)	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	3	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 53

Table 31. Modoc Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
East, West, Middle Modoc Creek and upper Mainstem Modoc Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	3	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	75
			Walla Walla TMDL – Deciduous Zone (Figure 8)	90
			Willamette Basin TMDL – Qg1 (Appendix C)	80
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	50
				Target Average = 74
Lower Modoc creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*	5	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Walla Walla TMDL – Deciduous Zone (Figure 8)	85
			Willamette Basin TMDL – Qg1 (Appendix C)	70

			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 61

Table 32. Threemile Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper East Threemile Creek and Upper Middle Threemile Creek	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	3	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	80
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	90
			Willamette Basin TMDL – Qalf (Appendix C)	76
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	86
				Target Average = 83
Lower East Threemile Creek and Middle Threemile Creek	Quaking aspen (*Populus tremuloides*)/red-osier dogwood (*cornus stolonifera*)	4	Alvord Lake TMDL - Co-dominant Aspen-Willow C ommunity (Figure 2.38)	80
			Walla Walla TMDL – Deciduous Zone (Figure 8)	85
			Willamette Basin TMDL – Qg1 (Appendix C)	75
				Target Average = 80
West Threemile Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	3	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	75
			Willamette Basin TMDL – Qg1 (Appendix C)	80
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	50
				Target Average = 70
Mainstem Threemile Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	5	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 53

Table 33. East Camas Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper East Camas Creek	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	4	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	79
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	87
			Willamette Basin TMDL – Qalf (Appendix C)	72
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	86
				Target Average = 81
Lower East Camas Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	8	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	45
			Willamette Basin TMDL – Qg1 (Appendix C)	67
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	21
				Target Average = 44

Table 34. West Camas Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper West Camas Creek	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	4	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	79
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	87
			Willamette Basin TMDL – Qalf (Appendix C)	72
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	86
				Target Average = 81
Middle West Camas Creek	(*Populus tremuloides*)/red-osier dogwood (*cornus stolonifera*)	8	Alvord Lake TMDL - Co-dominant Aspen-Willow Community (Figure 2.38)	59
			Walla Walla TMDL – Deciduous Zone (Figure 8)	79
			Willamette Basin TMDL – Qg1 (Appendix C)	67
				Average = 68
Lower West Camas Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	9	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 40

Target values are established in consideration of Idaho's existing numeric criteria for salmonid spawning and cold water aquatic life. It is expected that riparian shading at or around the target value will provide stream temperatures where beneficial uses are supported. It is expected that if potential natural vegetation is achieved and stream temperatures exceed the criteria, beneficial uses will be supported at system potential. This temperature TMDL is based on meeting potential natural riparian vegetation conditions in the watershed. Shade targets were developed with the idea that once shade levels are met, streams will achieve temperatures consistent with those achievable under natural conditions. Once natural conditions are known, natural background provisions of Idaho water quality standards (IDAPA 58.01.02.200.09) will apply and the applicable water quality criteria will not apply.

Monitoring Points

Monitoring points for this TMDL address subsurface sediment, streambank stability, riparian shading, and temperature monitoring, all of which are discussed in the following.

Subsurface Sediment

Subsurface sediment substrate monitoring points shall occur in habitat determined suitable for salmonid spawning within listed stream segments using the McNeil core sediment sampling method. The amount of habitat suitable for salmonid spawning will increase after the implementation of management practices identified to reduce fine sediment.

Streambank Stability

Streambank erosion inventories/assessments shall occur on sediment-impaired streams to evaluate overall bank stability.

Temperature Monitoring

Stream temperatures will be monitored with an instream temperature logger in previously established monitoring sites to maintain consistency.

Riparian Shade

Riparian shade shall be monitored with a solar pathfinder in temperature impaired streams to determine percentage of effective shading and evaluate long term trends in stream riparian conditions.

5.2 Load Capacity

A load capacity is “the greatest loading a waterbody can receive without violating water quality standards” [40 CFR §130.2]. This must be at a level to meet “...water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge...” (Clean Water Act § 303(d)(C)). Likely sources of uncertainty include lack of knowledge of assimilative capacity, uncertain relation of selected target(s) to beneficial use(s), and variability in target measurement.

Load capacities are defined for sediment and temperature as discussed in the following.

Sediment

The load capacity for sediment from streambank erosion shall be based on assumed natural streambank stabilities of greater than or equal to 80% (Overton et al 1995). Because it is presumed that beneficial uses were or would be supported at natural background sediment loading rates, the loading capacity lies somewhere between the current loading level and sediment loading from natural streambank erosion.

- Natural background loading rates are not necessarily the loading capacities. An adaptive management approach will be used to provide reductions in sediment loading based on best management practice (BMP) usage coupled with data collection and monitoring to determine the loading point at which beneficial uses are supported.

- The estimated capacity is directly related to the improvement of riparian vegetation density and structure as well as maintenance of roads and stream crossings. Increased vegetative cover provides a protective covering of streambanks, reduces lateral recession, traps sediment, and reduces erosive energy of the stream.

There is a large degree of uncertainty as to the percentage of sediment loading available before beneficial uses are no longer supported. Because it is presumed that beneficial uses were or would be supported at natural background sediment loading rates, the loading capacity lies somewhere between the current loading level and sediment loading from natural erosion.

Temperature

The loading capacity for a stream under PNV is essentially the solar loading allowed under the shade targets specified for the reaches within the stream. These loads are determined by multiplying the solar load to a flat plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e. the fraction open or 1 – shade fraction). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under the target is 40% (or 0.4) of the load hitting the flat plate collector.

Solar load data was obtained from flat plate collectors from the closest National Renewable Energy Laboratory (NREL) weather station in Pocatello, ID. The solar loads used in this TMDL are spring/summer averages, thus we used an average load for the seven month period from April through October. These months coincide with time of year that stream temperatures are increasing and when deciduous vegetation is in leaf. Table 29 and Appendix J show the PNV shade targets (identified at Target or Potential Shade) and their corresponding potential summer load (in KWh/m^2/day) that serve as the loading capacities for the streams.

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Sediment

Estimated existing pollutant loads for streambank sediment are based on streambank erosion inventories conducted by the DEQ in 2004. The current sediment loading-rate for Camas Creek in the Beaver-Camas Subbasin is quantitatively estimated in tons/mile/year, as shown in Table 35.

Temperature

Estimated existing pollutant loads for solar radiation are based on field measurements with the Solar Pathfinder and aerial photo interpretations of percent canopy cover (Figures 62-68). The percent daily total solar radiation was converted to solar load (kWh/m^2/day) by multiplying the open fraction times the average summer (April-October) solar radiation measure by a flat plate collector at the National Renewable Energy Lab (NREL) in Pocatello, Idaho. Table 36 shows the calculated estimated load for temperature TMDL streams in the subbasin. Appendix J lists the estimated existing canopy cover and estimated existing load for stream segments.

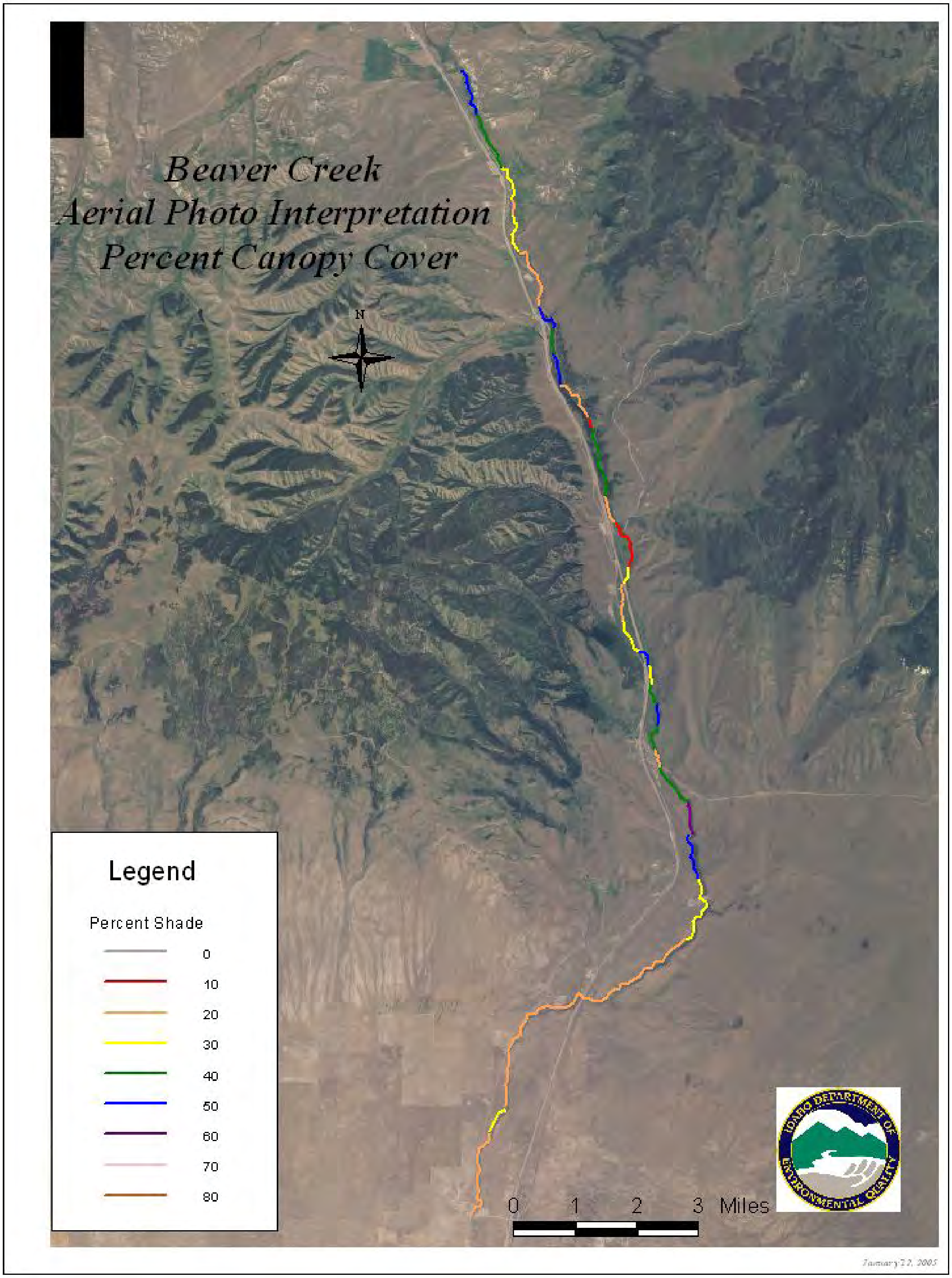


Figure 62. Estimated Percent Canopy Cover for Beaver Creek

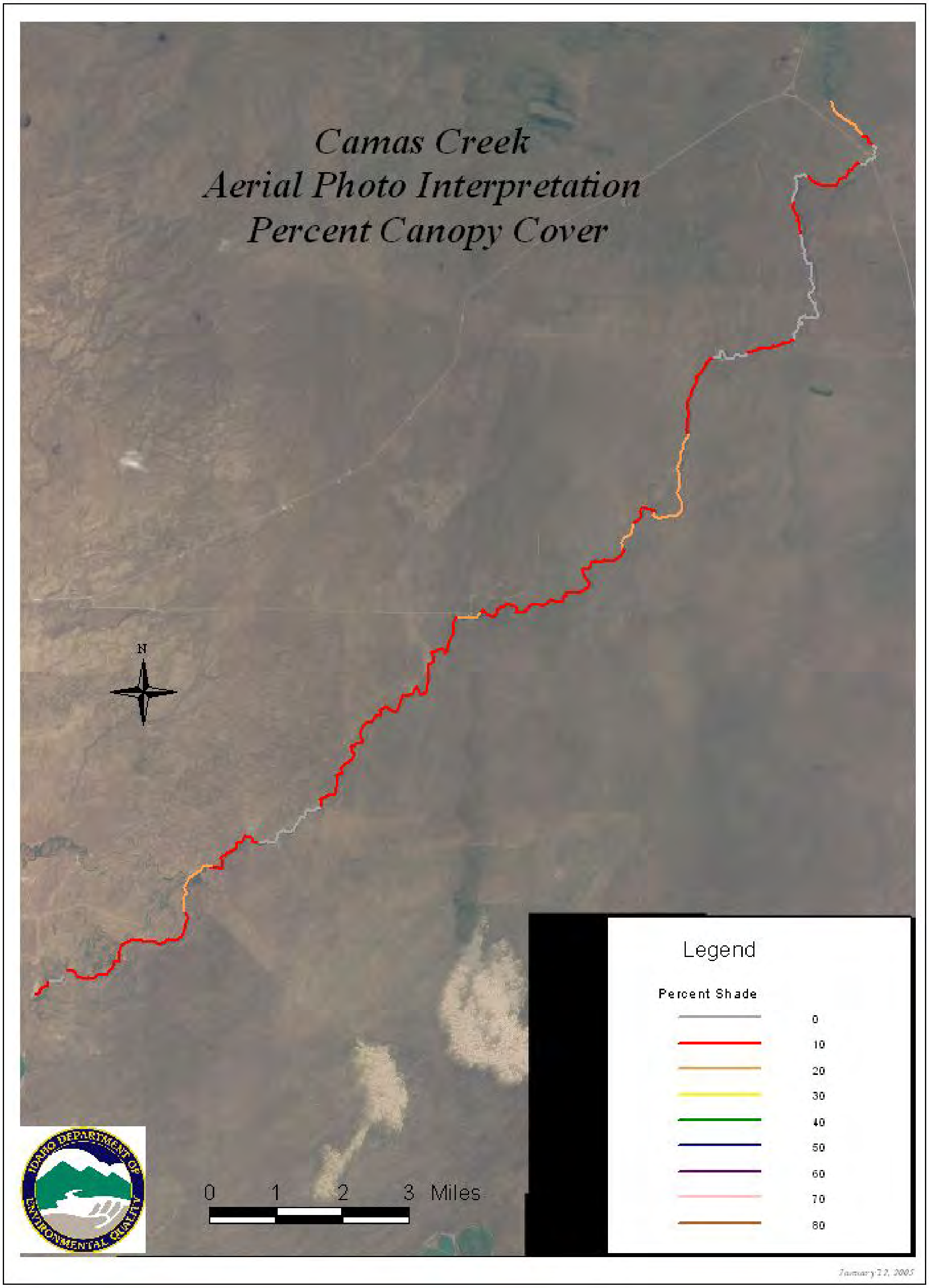


Figure 63. Estimated Percent Canopy Cover for Camas Creek

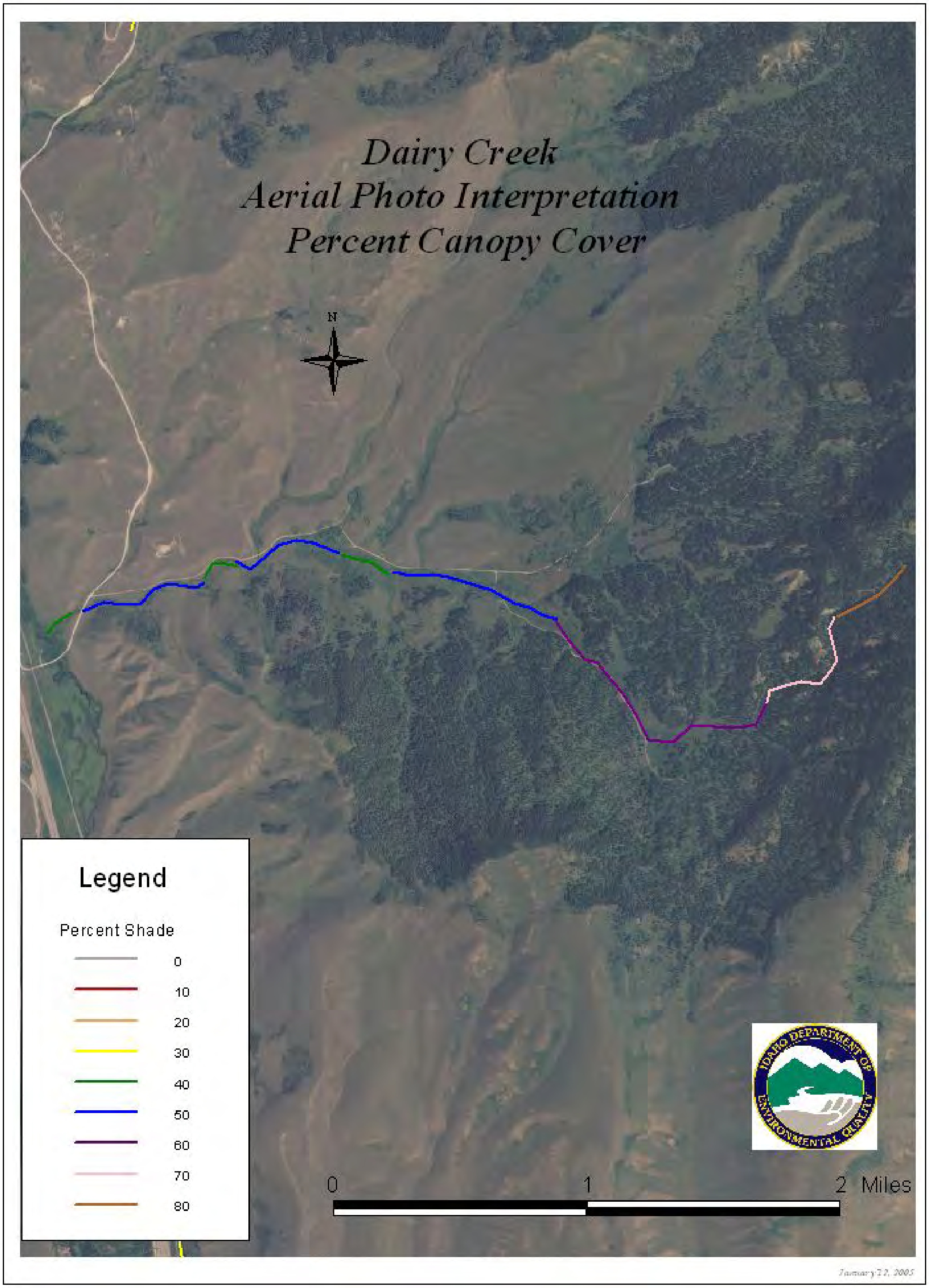


Figure 64. Estimated Percent Canopy Cover for Dairy Creek

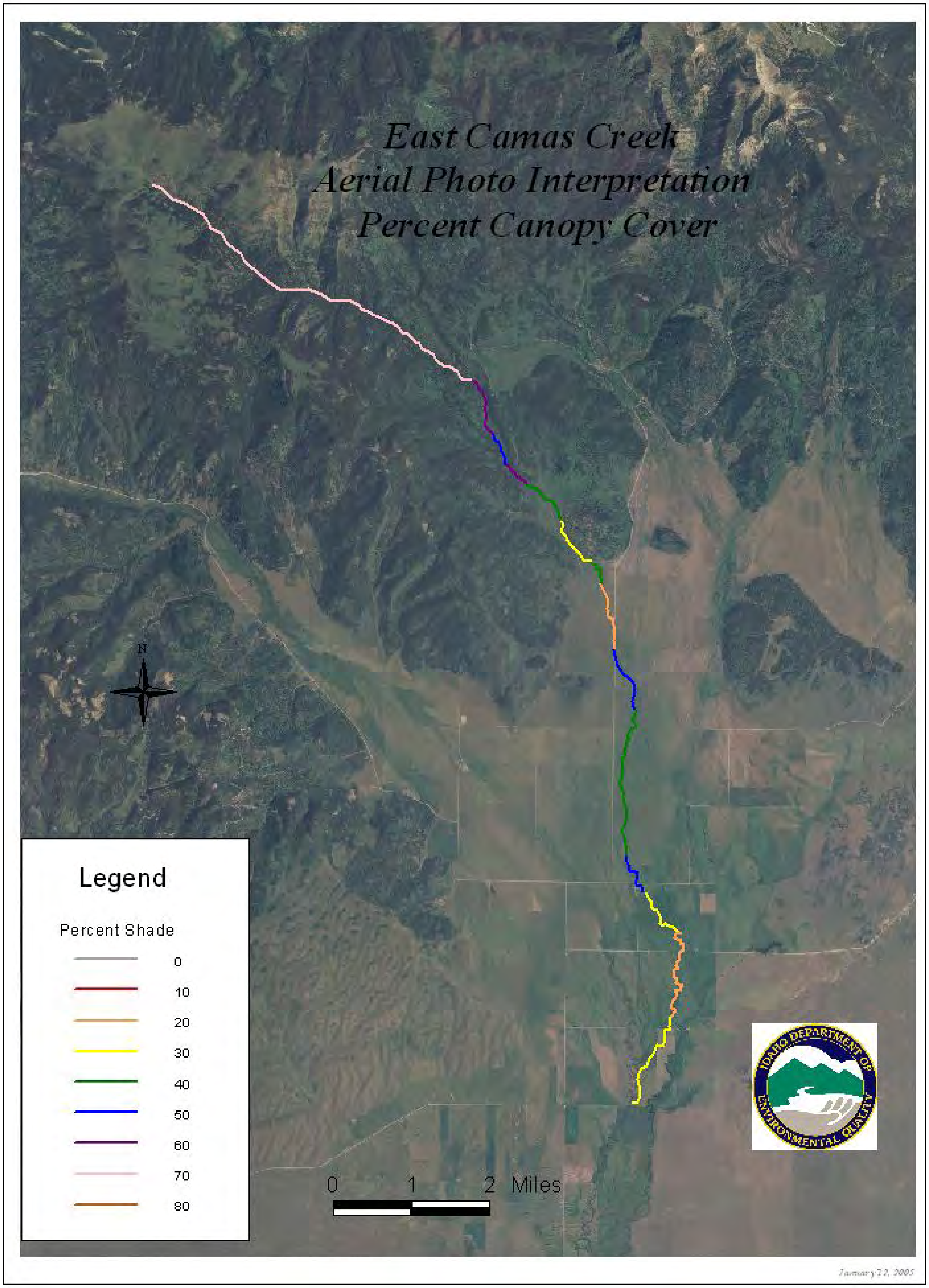


Figure 65. Estimated Percent Canopy Cover for East Camas Creek

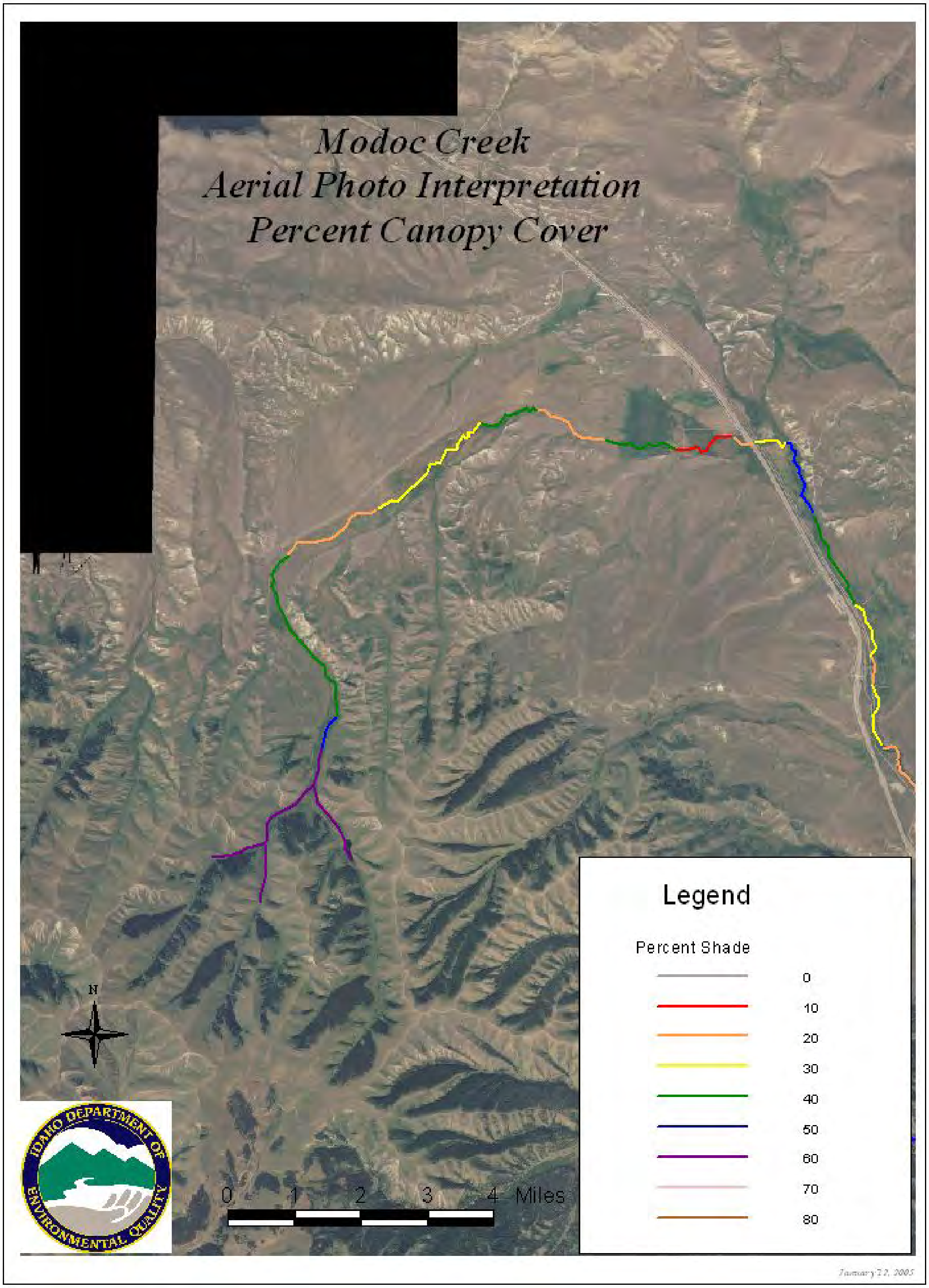


Figure 66. Estimated Percent Canopy Cover for Modoc Creek

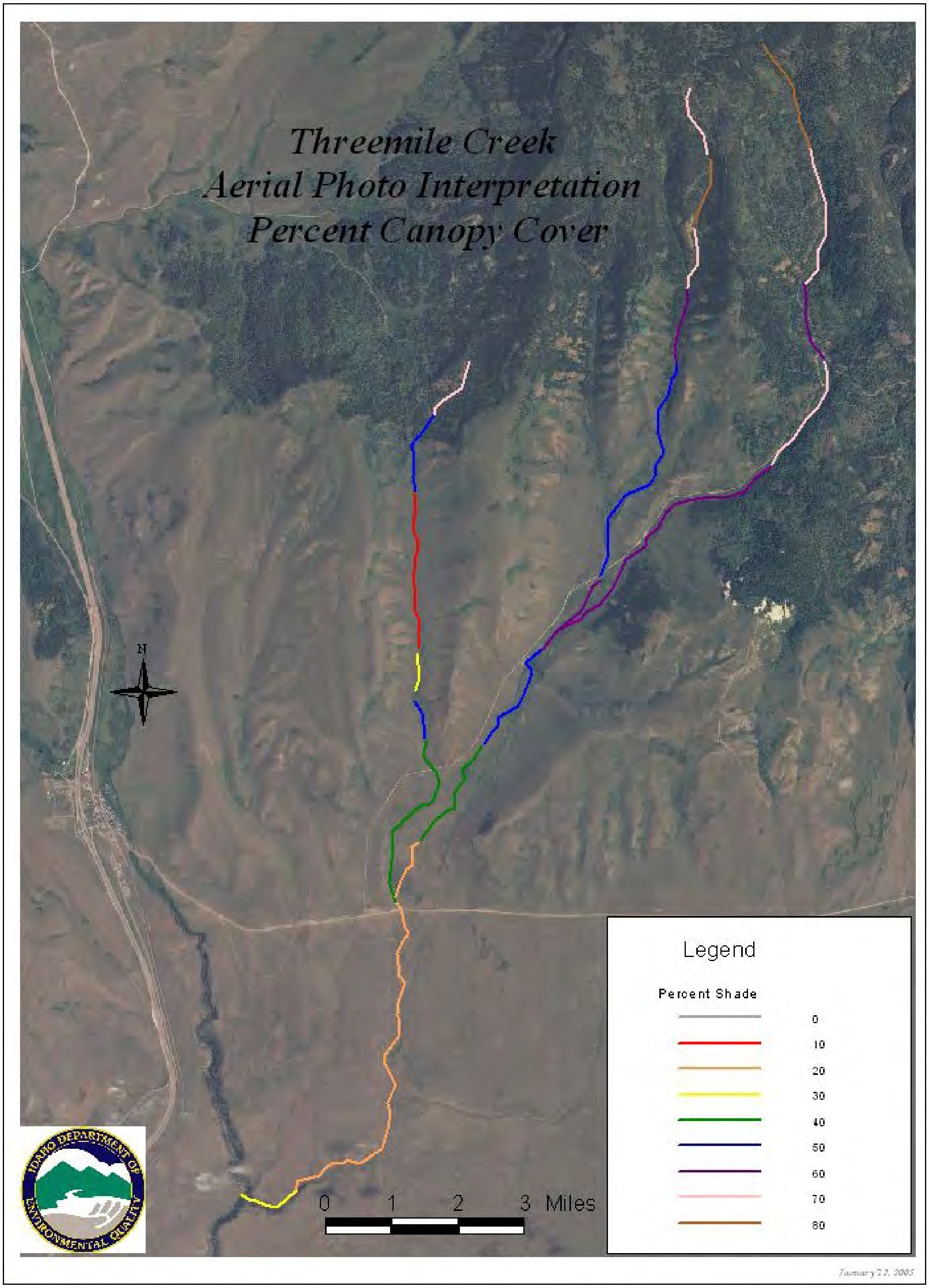


Figure 67. Estimated Percent Canopy Cover for Threemile Creek

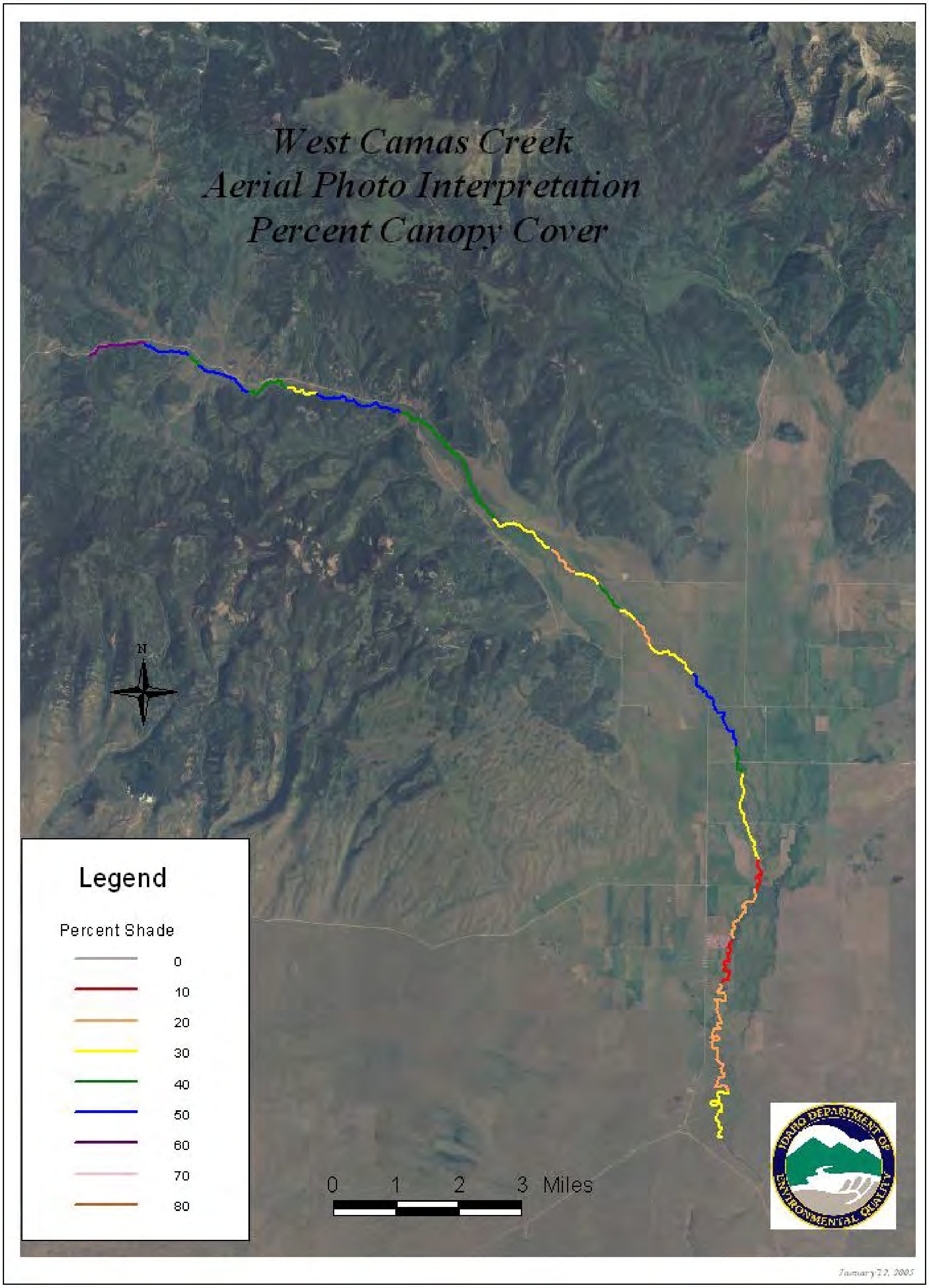


Figure 68. Estimated Percent Canopy Cover for West Camas Creek

5.4 Load Allocation

Wasteload Allocations

Because there are no point source discharges in the Beaver-Camas Subbasin, there are no wasteload allocations (WLA) in the TMDL.

Load Allocations

For the Beaver-Camas Subbasin, sediment and temperature load allocations have been developed, as shown on Tables 35 and 36. The load allocation is the amount of loading capacity allocated to a given source without exceeding water quality criteria.

Sediment

The sediment load allocation for Camas Creek was developed from streambank erosion inventories conducted by the DEQ in accordance with methods outlined in the section 2.4 of this document.

Temperature

The temperature load allocations for Beaver, Camas, Dairy, East Camas, Modoc, Threemile, and West Camas Creeks were developed in accordance with methodologies discussed in section 2.3 of this document. The difference between the current solar load (kWh/m^2/day) and the load capacity (target) is the load allocation (kWh/m^2/day).

Table 35. Sediment load allocations for Beaver-Camas Subbasin.

Stream	CURRENT LOAD Existing Erosion Rate (t/mi/yr)	LOAD CAPACITY Erosion Rate (t/mi/yr)	LOAD ALLOCATION Total Erosion Rate Reduction (t/mi/yr)	Total Erosion % Reduction to Meet Load Capacity
Camas Creek	1482	406	-1076	73

Table 36. Temperature load allocations for Beaver-Camas Subbasin

Stream	CURRENT LOAD Existing Summer Load (kWh/m^2/day)	LOAD CAPACITY Potential Summer Load (kWh/m^2/day)	LOAD ALLOCATION Load Capacity minus Current Load (kWh/m^2/day)	% Reduction to Meet Load Capacity
Beaver Creek	4.08	3.34	-0.74	18
Camas Creek	5.56	4.47	-1.09	20
Dairy Creek	3.08	2.41	-0.46	15
East Camas Creek	3.56	2.79	-0.76	21
Modoc Creek	3.78	2.11	-1.66	44
Threemile Creek	2.85	1.74	-1.11	39
West Camas Creek	3.92	2.36	-1.36	35

Margin of Safety

The margin of safety (MOS) factored into sediment load allocations is implicit. The MOS includes the conservative assumptions used to develop existing sediment loads. Conservative assumptions made as part of the sediment loading analysis include the following:
Desired bank erosion rates are representative of assumed natural background conditions.
Water quality targets for percent depth fines are consistent with values measured and are set by local land management agencies based on established literature values, incorporating an adequate level of fry survival to provide for stable salmonid production.

The margin of safety in this TMDL is implicit in the development of the potential effective shade. Effective shade is based on the hypothesis that the stream will experience a complete potential natural vegetal community along its borders all of the time. In reality, plant communities vary considerably with time as a result of natural disturbance (fire) and differential growth rate of plant species. Natural shade conditions are considered in this TMDL to be equivalent to natural temperature conditions, and that is the coolest the stream can achieve.

Seasonal Variation

Seasonal variability was built into this TMDL by developing sediment loads using annual average rates determined from empirical characteristics that developed over time within the influence of runoff events and peak and base flow conditions. Streambank erosion inventories take into account that most bank recession occurs during peak flow events, when the banks are saturated. The estimated annual average sediment delivery is a function of bankfull discharge. It is assumed that the accumulation of sediment within dry channels is continuous until flow resumes and the accumulated sediment is transported and deposited.

Temperature criteria are applied to different time periods due to differences in life histories of target species and different regulatory conventions. The target species in this analysis has been spawning and rearing salmonids. Considering the fact that potential natural vegetation estimations include deciduous species as well as conifers, the effective shade calculation targets the summer time period when the canopy should be at its greatest extent.

Climatic conditions vary from year to year, however, the target effective shade should be consistent from year. The majority of plant species considered are either long lived or receive their watering needs from the stream itself. The meadow is one area that may have its canopy cover more affected by drought conditions than other habitat types.

Background

Natural background loading rates are assumed to be the natural sediment loading capacity of 80% or greater streambank stability and 28% or less subsurface fine sediment. Therefore, natural background is accounted for in the load capacity.

Reserve

If uses are supported at load levels different than those specified in the TMDL, then there may be some reserve capacity to adjust the TMDL loads.

Construction Storm Water and TMDL Waste Load Allocations

Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past, storm water was treated as a non-point source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development) that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit (CGP), operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically, and maintain the best management practices (BMPs) through the life of the project.

Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed, DEQ now incorporates a gross waste load allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically, there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

Remaining Available Load

Since the entire load allocation is given to current nonpoint sources, assuming those sources can achieve the desired reductions, there is no remaining available load for future allocation.

5.5 Implementation Strategies

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Several designated land management agencies are involved where watershed implementation is concerned. The largest portion of the watershed, with perennial water, consists of private and forest service land. The Idaho Association of Soil Conservation Districts (IASCD) and the USFS will provide implementation strategies for riparian management for the areas that fall under their realm of jurisdiction. A much smaller portion of the watershed is made up of BLM and state land, both of which are responsible for developing an implementation plan.

Time Frame

The expected time frame for attaining the water quality standard and restoring beneficial use is a function of management intensity, climate, ecological potential, and natural variability of environmental conditions. If implementation of best management practices is embraced enthusiastically, some improvements may be seen in as little as several years. Even with aggressive implementation, however, some natural processes required for satisfying the requirements of this TMDL may not be seen for many years. The deleterious effects of historic land management practices have accrued over many years and recovery of natural systems may take longer than administrative needs allow for.

Approach

It is anticipated that by improving riparian management practices, overall riparian zone recovery will precipitate streambank stabilization, reduce sedimentation, increase canopy cover, and lower stream temperatures, all of which will precipitate overall stream habitat improvements. Such improvements will contribute to an overall improvement in stream morphology and habitat, shifting stream health towards beneficial use attainment.

Responsible Parties

The IASCD, IDL, BLM, and USFS are the identified as the federal and state entities that will be involved in or responsible for implementing the TMDL.

Monitoring Strategy

It is presumed that instream temperatures will continue to be monitored with temperature loggers to evaluate improvements or declines in temperature regimes. Streambank erosion inventories are intended for rapid assessment, but will allow for the evaluation of streambank condition in the absence of more rigorous evaluation. Stream subsurface fine sediment should continue to be assessed through McNeil sediment core sampling at established intervals to identify trends toward meeting sediment targets. Beneficial Use Reconnaissance Program monitoring will continue to be conducted by DEQ and should also provide insight regarding steam conditions.

5.6 Conclusions

As shown by Table 37, the primary water quality concern in the watershed is elevated stream temperatures. To address this concern, eight temperature TMDLs have been written to address this non-point source pollutant. Elevated temperatures in the basin are attributed to riparian vegetation disturbance and the unique hydrologic features that occur in the Beaver-Camas Subbasin. The complex system of gaining reaches in the upper, mountainous regions, and loosing reaches in the lower basalt dominated regions contribute to divergent stream characteristics between the upper and lower sections of the basin. As the subbasin assessment shows, natural flow losses coupled with irrigation water removal from the stream make it difficult to attain beneficial use support in select streams. Where flow limitations do not completely impede beneficial use support, a temperature TMDL was developed for the streams with documented exceedances in the temperature criteria.

Beaver, Dairy, East Camas, Modoc, Threemile, and West Camas Creeks support active beaver complexes which may increase stream temperatures by reducing stream flows and holding water back in stagnant pools where thermal loading to the stream is higher.

The only sediment TMDL in the basin was developed for Camas Creek. Riparian grazing is the principal land use around Camas Creek. Stream characteristics of Camas Creek alternate between basalt canyons and depositional openings between canyons. The areas where the basal canyons do not armor the banks experience the highest grazing pressure and grazing impacts; hence, streambank erosion results in sedimentation.

Table 37. Summary of assessment outcomes.

Water Body Segment	Assessment unit of 17040214	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Beaver Creek* (Spencer to Dubois)	SK015_05	Flow	No	List below Exit 172 and de-list above Exit 172	Flow Altered (natural)
		Habitat	No	None	EPA Policy
		Nutrients	No	De-list	No Exceedances Documented
		Sediment	No	De-list	No Impacts Documented
		Temperature	Yes	None	Exceedances Documented
Beaver Creek* (Dubois to Camas Creek)	SK003_05 SK014_05	Flow	No	None	Flow Altered (natural and anthropogenic)
		Habitat	No	None	EPA Policy
		Nutrients	No	None	Flow Altered (natural and anthropogenic)
		Sediment	No	None	Flow Altered (natural and anthropogenic)
		Temperature	No	None	Flow Altered (natural and anthropogenic)
Beaver Creek (Headwaters to Spencer)	SK021_02 SK021_03 SK020_03 SK018_04 SK024_02	Temperature	Yes	None	Exceedances Documented
Camas Creek* (Spring Creek to Hwy 91)	SK002_05	Flow	No	List below T9N, R37E, Section 16 and de-list above	EPA Policy
		Habitat	No	None	EPA Policy
		Nutrients	No	De-list	No Exceedances Documented
		Sediment	Yes	None	Impacts Documented
		Temperature	Yes	None	Impacts Documented
Camas Creek* (Hwy 91 to Mud Lake)	SK001_06	Flow	No	None	Flow Altered (natural and anthropogenic)
		Nutrients	No	De-list	Flow Altered (natural and anthropogenic)
		Sediment	No	De-list	Flow Altered (natural and anthropogenic)
Cow Creek* (Headwaters to Thunder Gulch)	SK018_04	Unknown	No	List	Flow Altered (natural)
Dairy Creek (Headwaters to Mouth)	SK018_02	Temperature	Yes	None	Exceedances Documented
East Camas Creek (Headwaters to Mouth)	SK011_03 SK010_02 SK010_03	Temperature	Yes	None	Exceedances Documented
Modoc Creek (Headwaters to Mouth)	SK021_02	Temperature	Yes	None	Exceedances Documented
Threemile Creek (Headwaters to Mouth)	SK017_02 SK017_03	Temperature	Yes	None	Exceedances Documented
West Camas Creek (Headwaters to Mouth)	SK012_03 SK013_02 SK013_03	Temperature	Yes	None	Exceedances Documented

References Cited

Abramovich, R., M. Molnau, and K. Craine. 1998 Climates of Idaho. University of Idaho College of Agriculture. Moscow, ID. 216 pp.

American Geological Institute. 1962. Dictionary of geological terms. Doubleday and Company. Garden City, NY. 545 pp.

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society. Bethesda, MD. 136 pp.

Batt, P.E. 1996. Governor Philip E. Batt's Idaho bull trout conservation plan. State of Idaho, Office of the Governor. Boise, ID. 20 p + appendices.

Clean Water Act (Federal water pollution control act), 33 U.S.C. § 1251-1387. 1972.

Compton, R.R. 1996. Interpretation of aerial photos.

Denny, P. 1980. Solute movement in submerged angiosperms. Biology Review. 55:65-92.

EPA. 1996. Biological criteria: technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water. Washington, DC. 162 p.

Flanagan, D.C., and M.A. Nearing (Editors). USDA Water Erosion Prediction Project, Hillslope Profile and Watershed Model Documentation. NSERL Report No. 10., USDA-ARS National Soil Erosion Laboratory, W. Lafayette IN. 9.1-9.16

Franson, M.A.H., L.S. Clesceri, A.E. Greenberg, and A.D. Eaton, editors. 1998. Standard methods for the examination of water and wastewater, twentieth edition. American Public Health Association. Washington, DC. 1,191 pp.

Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002. The Idaho Department of Environmental Quality water body assessment guidance, second edition-final. Department of Environmental Quality. Boise, ID. 114 pp.

Hall, T.J. 1986. A laboratory study of the effects of fine sediments on survival of three species of Pacific salmon from eyed egg to fry emergence. National Council of the Paper Industry for Air and Stream Improvement. Technical Bulletin 482. New York.

Hughes, R.M. 1995. Defining acceptable biological status by comparing with reference condition. In: Davis, W.S. and T.P. Simon, editors. Biological assessment and criteria: tools for water resource planning and decision making. CRC Press. Boca Raton, FL. pp 31-48.

Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.

Idaho Code § 39.3615. Creation of watershed advisory groups.

Idaho Department of Environmental Quality. 2002. Middle Salmon River-Chamberlain Creek Subbasin Assessment and Crooked Creek Total Maximum Daily Load. Idaho Department of Environmental Quality: Boise, ID. 222 pp.

Idaho Department of Environmental Quality. 2002. South Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads. Idaho Department of Environmental Quality: Boise, ID

IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.

IDEQ. 1999b. 1998 303(d) List. Idaho Division of Environmental Quality. Surface Water Program. January. 473 pp.

IDL. 2000. Forest Practices Cumulative Watershed Effects Process for Idaho. Idaho Department of Lands. March 2000.

Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications 1:66-84.

Leopold, L.B., M.G. Wolman and J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman. San Francisco, CA.

Lohrey, M.H. 1989. Stream channel stability guidelines for range environmental assessment and allotment management plans. U.S. Forest Service, Northwest Region (unpublished).

Newcombe, C.P. and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. Volume 16(4): 693-727.

ODEQ. 2003. Alvord Lake Subbasin Total Maximum Daily Load (TMDL) & Water Quality Management Plan (WQMP). Oregon Department of Environmental Quality: Portland, OR. 163 pp.

ODEQ. 2004. Walla Walla River Subbasin Stream Temperature Total Maximum Daily Load and Water Quality Management Plan. Oregon Department of Environmental Quality: Portland, OR

ODEQ. 2004. Potential Near-Stream Land Cover in the Willamette Basin for Temperature Total Maximum Daily Loads (TMDLs) Oregon Department of Environmental Quality: Portland, OR

Padgett, W.G., Youngblood, A.P., and Winward, A.H. 1989. Riparian Community Type Classification of Utah and Southeastern Idaho. United States Department of Agriculture. 189 pp.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. U.S. Forest Service, Northern Region. Missoula, MT.

Rand, G.W., editor. 1995. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition. Taylor and Francis. Washington, DC. 1,125 pp.

Rosgen, D.L. 1996 Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO. 378pp.

Shumar, M. January 20, 2005. Personal Communication. Estimating canopy cover target values via aerial photography.

Solar Pathfinder. 2002. Instruction Manual for the Solar Pathfinder. Copyright 2002 Solar Pathfinder, Linden, TN.

Stevenson, T.K. 1994. USDA-NRCS, Idaho. Channel erosion condition inventory description. Memorandum to Paul Shelton, District Conservationist, Montpelier FO, Idaho, 5/24/94: describing estimation of streambank, road and gully erosion.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions American Geophysical Union 38:913-920.

University of Idaho. 1983. Field Guide to the Willows of East-Central Idaho. University of Idaho: Moscow, ID.

USDA FS. 1997. Challis Creek Watershed Analysis. Salmon-Challis National Forest, Challis Ranger District. June 1997.

USDA. 1999. A procedure to estimate the response of aquatic systems to changes in phosphorus and nitrogen inputs. National Water and Climate Center, Natural Resources Conservation Service. Portland, OR.

USDA NRCS. 1983.Channel evaluation Workshop, Ventura, California, November 14-18, 1983. Presented at U.S. Army Corps of Engineers Hydrologic Engineering Center training session by Lyle J. Steffen, Geologist, Soil Conservation Service, Davis, CA. December 14, 1982.

USGS. 1987. Hydrologic unit maps. Water supply paper 2294. United States Geological Survey. Denver, CO. 63 p.

Water Environment Federation. 1987. The Clean Water Act of 1987. Water Environment Federation. Alexandria, VA. 318 p.

Water Quality Act of 1987, Public Law 100-4. 1987.

Water quality planning and management, 40 CFR Part 130.

Wetzel, R.G. 1983. Limnology. Saunders College Publishing. New York, NY.

GIS Coverages

Restriction of liability: Neither the state of Idaho nor the Department of Environmental Quality, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. The Department of Environmental Quality may update, modify, or revise the data used at any time, without notice.

Glossary

305(b)

Refers to section 305 subsection "b" of the Clean Water Act. The term "305(b)" generally describes a report of each state's water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

§303(d)

Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.

Aeration

A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.

Aerobic

Describes life, processes, or conditions that require the presence of oxygen.

Adjunct

In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin

A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.

Algae

Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

Alluvium

Unconsolidated recent stream deposition.

Ambient

General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).

Anadromous

Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the saltwater but return to fresh water to spawn.

Anaerobic

Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.

Anthropogenic

Relating to, or resulting from, the influence of human beings on nature.

Anti-Degradation

Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

Aquatic

Occurring, growing, or living in water.

Aquifer

An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.

Assemblage (aquatic)

An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).

Assessment Unit (AU)

A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses,

	and any associated causes and sources must be applied to the entirety of the unit.
Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
Batholith	A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, and wadeable streams and rivers
Benthic	Pertaining to or living on or in the bottom sediments of a water body
Benthic Organic Matter.	The organic matter on the bottom of a water body.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Biological Integrity	1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.
Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, *E. Coli*, and Pathogens).
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/centimeter at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.
Cubic Feet per Second	A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Decomposition	The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.
Depth Fines	Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).
Designated Uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved Oxygen (DO)	The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.
Disturbance	Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.
E. coli	Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Ecological Indicator	A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and

	sustainability. Ecological indicators are often used within the multimetric index framework.
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving water body.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.
Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Existing Beneficial Use or Existing Use

A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).

Extrapolation

Estimation of unknown values by extending or projecting from known values.

Fecal Coliform Bacteria

Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria, *E. coli*, and Pathogens).

Flow

See *Discharge*.

Fluvial

In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.

Focal

Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Fully Supporting Cold Water

Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions.

Fully Supporting but Threatened

An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a "not fully supporting" status.

Geographical Information Systems (GIS)
A georeferenced database.

Geometric Mean
A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

Gradient
The slope of the land, water, or streambed surface.

Ground Water
Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.

Growth Rate
A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.

Habitat
The living place of an organism or community.

Headwater
The origin or beginning of a stream.

Hydrologic Basin
The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle
The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.

Hydrologic Unit
One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic

units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Inorganic

Materials not derived from biological sources.

Instantaneous

A condition or measurement at a moment (instant) in time.

Intergravel Dissolved Oxygen

The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.

Intermittent Stream

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

Land Application

A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.

Limiting Factor

A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.

Limnology

The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.

Load Allocation (LA)	A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).
Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Load(ing) Capacity (LC)	A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.
Loam	Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.
Loess	A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.
Luxury Consumption	A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.
Macroinvertebrate	An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.
Macrophytes	Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL

(generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Mass Wasting
A general term for the down slope movement of soil and rock material under the direct influence of gravity.

Mean
Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Median
The middle number in a sequence of numbers. If there are an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; 6 is the median of 1, 2, 5, 7, 9, 11.

Metric
1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.

Milligrams per Liter (mg/L)
A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).

Million Gallons per Day (MGD)
A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.

Miocene
Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.

Monitoring
A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth
The location where flowing water enters into a larger water body.

National Pollution Discharge Elimination System (NPDES)
A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nitrogen

An element essential to plant growth, and thus is considered a nutrient.

Nonpoint Source

A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)

A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.

Not Attainable

A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Not Fully Supporting Cold Water

At least one biological assemblage has been significantly modified beyond the natural range of its reference condition.

Nuisance

Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.

Nutrient

Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.
Pathogens	A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. *E. coli*, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.
Perennial Stream	A stream that flows year-around in most years.
Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
Plankton	Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training (Rand 1995). The goal of QA is to assure the data provided are of the quality needed and claimed (EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples (Rand 1995). QC is implemented at the field or bench level (EPA 1996).
Quantitative	Descriptive of size, magnitude, or degree.
Reach	A stream section with fairly homogenous physical characteristics.
Reconnaissance	An exploratory or preliminary survey of an area.

Reference

A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments.

Reference Condition

1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site

A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Resident

A term that describes fish that do not migrate.

Respiration

A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.

Riffle

A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Riparian

Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

River

A large, natural, or human-modified stream that flows in a defined course or channel or in a series of diverging and converging channels.

Runoff

The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a water body.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.
Storm Water Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.
Stressors	Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Subbasin

A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.

Surface Fines

Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff

Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Taxon

Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).

Threatened Species

Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Tributary

A stream feeding into a larger stream or lake.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary

A stream feeding into a larger stream or lake.

Turbidity

A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Wasteload Allocation (WLA)
The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body
A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Column
Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Pollution
Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water Quality
A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Criteria
Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.

Water Quality Limited
A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.

Water Quality Limited Segment (WQLS)
Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."

Water Quality Management Plan

A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.

Water Quality Standards

State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Water Table

The upper surface of ground water; below this point, the soil is saturated with water.

Watershed

1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body.

Water Body Identification Number (WBID)

A number that uniquely identifies a water body in Idaho and ties in to the Idaho water quality standards and GIS information.

Wetland

An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Young of the Year

Young fish born the year captured, evidence of spawning activity.

Appendix A. Beneficial Use Reconnaissance Program Stream Data

Table A-1. BURP Data for streams in the Beaver-Camas Subbasin

Site	Same	Stream	Elev	Strm	Ros	%	W/D	% Stable		% Cov	
ID No.	As	Name	Feet	Ord	Typ	Fns	Rat	LB	RB	LB	RB
02-A004		Alex Draw	6840	2	B						
01-A058		Bear Gulch Creek	6680	2	B	35	20	100	100	100	64
96-Z049		Bear Gulch Creek East Fork	6680	1	A	73	18	100	100	97	99
95-B060		Beaver Creek	5900	3	C	24	12	62	62	62	56
02-A021		Beaver Creek	5520	5							
03-A087		Beaver Creek	5415	4							
95-B062		Beaver Creek	5200	3	C	39	17	20	48	40	32
01-A055		Beaver Creek	5140	3							
03-A101		Beaver Creek	5117	4							
95-B063		Beaver Creek	5080	3	C	18	32	78	80	0	0
95-B035		Beaver Creek	4800	4							
98-C026		Berry Creek	6720	1	E	96	3	94	94	100	100
02-A019		Brooks Canyon Creek	6980	1	C						
03-A069		Brooks Canyon Creek	6750	1							
95-B061		Camas Creek	5641	4							
95-B036		Camas Creek	4800	4							
95-B064		Camas Creek	4795	5							
03-A102		Camas Creek	4800								
95-B065		Camas Creek	4785	5							
96-Z060		Camp Creek	6380	1							
96-Z042		Castle Creek	6925	1	A	80	9	100	97	100	100
02-A007		Castle Creek	6860	1							
01-A057		Castle Creek	6760	1	B	47	28	100	83	100	83
98-C031		Chicken Creek	6520	1	E	57	10	92	70	90	100
98-C034		Ching Creek	6390	2	E	50	7	70	86	80	100
03-A095		Ching Creek	6400	3	C						
98-C011		Corral Creek	7120	1	A	42	7	94	95	100	100
98-C010		Corral Creek	6010	2	C	49	10	84	61	48	66
03-A093		Corral Creek	6058	2							
96-Z053		Cottonwood Creek	6710	3	B	26	46	100	100	76	90
02-A023	96-Z066	Cottonwood Creek East Fork	7635	1	C						
96-Z066	02-A023	Cottonwood Creek East Fork	7630	1	B	72	10	79	80	75	76
96-Z065		Cottonwood Creek West Fork	7780	1	B	68	25	59	81	55	52
02-A024		Cottonwood Creek West Fork	7640	1	C						
96-Z064		Cow Creek	7760	1	A	42	21	100	100	0	0
98-C033		Crab Creek	6395	2	C	65	26	64	89	100	93
03-A100		Crab Creek	6380	3							
03-A099		Crooked Creek	6380	2							
98-C032		Crooked Creek	6370	2	DA	88	5	22	14	100	100
98-C021		Dairy Creek	6320	1	E	38	6	96	92	97	99
98-C020		Dairy Creek	6070	2	E	21	8	68	97	86	95
03-A074		Dairy Creek	6030	2							
96-Z047		Disaster Creek	6825	1	A	89	6	98	95	98	95
02-A008		Disaster Creek	6714	1	A						
96-Z072		Ditch Creek	6910	2	B	80	11	0	0	100	89
98-C024		Dry Creek	5700	2	B	44	12	86	55	82	82
01-A060		Dry creek	5660	3							
96-Z054		East Camas Creek	6610	3	B	51	13	95	100	95	84
01-A059		East Camas Creek	6590	3	C	21	20	86	72	94	80
98-C029		East Modoc Creek	7520	1	F	45	5	94	100	98	100
03-A083		East Modoc Creek	7440	2							
98-C007		East Three Mile Creek	6900	1	B	38	7	64	77	76	72
03-A089		East Threemile Creek	6780	1							
98-C028		Horse Creek	7300	1	A	53	4	90	83	100	98
03-A085		Horse Creek	7320	1							
01-A049		Huntley Canyon Creek	5980	1	B	22	23	78	80	98	97
96-Z071		Idaho Creek	6940	1	B	62	28	1	0	81	71
02-A002	96-Z045	Jug Creek	6880	1							

96-Z045	02-A002	Jug Creek	6880	1	B	90	8	100	100	100	100
96-Z052		Kay Creek	6775	1	E	81	23	100	100	98	99
02-A018		Kite Canyon Creek	7000	1	B						
96-Z057		Kite Canyon Creek	6920	1	B	76	11	100	94	100	94
03-A067		Kite Canyon Creek	6920	1							
02-A026	96-Z063	Lava Creek	7800	1							
96-Z063	02-A026	Lava Creek	7760	1							
03-A096		Little Creek	6775	2							
98-C038		Little Creek	6670	2	B	64	8	97	94	100	100
03-A086		Long Creek	7040	1							
98-C025		Long Creek	6880	1	E	61	7	96	100	98	100
01-A061		Meadow Creek	6360	1							
96-Z056		Meadow Creek	6310	1	C	97	4	100	96	100	96
03-A076		Meadow Creek	6360	1							
03-A082		Middle Modoc Creek	7600	1							
98-C006		Middle Three Mile Creek	6560	1	A	25	9	92	86	69	80
98-C008		Middle Three Mile Creek West Fk	6350	1	A	45	14	59	50	79	67
03-A091		Middle Threemile Creek	6160	1							
98-C022		Miners Creek	6260	2	B	40	5	96	93	98	98
03-A075		Miners Creek	6195	2							
03-A084		Modoc Creek	7400	2							
98-C027		Modoc Creek	6710	2	F	50	6	92	100	100	100
02-A001		Pass Creek	7062	1							
96-Z050		Pass Creek	6875	1	E	94	2	100	100	100	100
03-A098		Pasture Creek	7000	2							
96-Z051		Pasture Creek	6990	2	B	65	28	97	99	90	96
01-A062		Patelzick Creek	7200	2	B	33	32	97	98	97	98
96-Z043		Pete Creek	6900	1	B	68	5	98	92	98	93
03-A079		Pete Creek	6765	2							
96-Z061		Picnic Hollow Creek	6340	1	A	88	13	100	100	100	100
03-A071		Picnic Hollow Creek	6300	1							
96-Z059		Pleasant Valley Creek	7160	1	B	62	13	92	98	58	46
03-A065		Pleasant Valley Creek	6920	2							
96-Z069		Pleasant Valley Creek	6820	2							
02-A020		Pleasant Valley Creek	6760	2	C						
03-A068		Pleasant Valley Creek	6760	2							
03-A070		Ramshorn Creek	6600	1							
98-C017		Rattlesnake Creek	6370	2	F	36	33	98	96	99	98
98-C012		Rattlesnake Creek	5930	3	D	40	35	75	55	69	69
03-A092		Rattlesnake Creek	5890	3							
98-C019		Rattlesnake Creek East Fork	6080	2	C	35	29	28	12	24	14
98-C009		Rattlesnake Creek North Fork	6020	1	F	82	10	0	24	48	47
03-A090		Rattlesnake Creek West Fork	6715	2							
98-C018		Rattlesnake Creek West Fork	6110	2	B	35	8	8	64	81	96
02-A022		Rock Creek	7480	1							
96-Z067		Rock Creek	7400	1							
98-C036		Saw Creek	6640	1	B	94	20	88	94	96	96
01-A048	96-Z070	School Section Creek	6440	1	B	59	25	69	68	96	100
96-Z070	01-A048	School Section Creek	6450	1	B	84	15	100	100	100	100
03-A077		Sheep Creek	6730	2							
98-C023		Sheep Creek	6660	2	B	56	5	0	13	100	95
04-A123		Spring Creek	6247	3							
98-C015		Spring Creek	6260	1	A	30	18	95	100	95	100
98-C014		Spring Creek	6126	2	C	51	25	72	52	98	100
03-A094		Spring Creek	6075	2							
98-C016		Spring Creek East Fork	6260	1	Aa+	35	9	100	96	97	94
96-Z048		Steel Creek	6680	2	A	77	6	98	97	98	97
02-A025		Steel Creek	6640	2	E						
96-Z055		Stoddard Creek	6730	1	A	63	18	97	96	74	84
03-A072		Stoddard Creek	6120	1							
02-A003	96-	Stump Creek	6840	1	B						

	Z046										
96-Z046	02-A003	Stump Creek	6860	1	B	76	18	100	83	100	87
98-C013		Three Mile Creek	5840	2	D	47	14	6	99	94	100
04-A005		Threemile Creek	5890	3							
02-A027		Thunder Gulch Creek	5800	1							
98-C037		Trail Creek	7040	2	A	51	11	87	82	91	100
03-A097		Trail Creek	7120	2							
04-A121		UNT to Beaver Creek	5029	3							
04-A122		UNT to Beaver Creek	6755	1							
04-A004		UNT to Beaver Creek	4845	1							
04-A039		UNT to East Camas Creek	6362	1							
98-C035		Van Noy Creek	6180	1	A	64	8	88	88	100	98
03-A073		Van Noy Creek	6125	1							
96-Z044		West Camas Creek	6880	2	E	73	5	94	94	98	100
03-A078		West Camas Creek	6880	2							
01-A056		West Camas Creek	6680	3	E	32	10	100	56	100	63
03-A080		West Camas Creek	6870	3	G						
04-A040		West Camas Creek	6490	3	C						
96-Z068		West Dry Creek	7740	1	B	69	27	100	100	100	100
98-C030		West Modoc Creek	7660	1	A	36	7	92	74	98	87
03-A081		West Modoc Creek	7640	1							
98-C005		West Three Mile Creek	6170	1	A	46	11	92	99	97	94
03-A088		West Threemile Creek	5090	1							
02-A017		White Pine Creek	7060	1	A						
03-A066		White Pine Creek	6920	1							
96-Z058		White Pine Creek	6920	1	A	88	7	98	100	98	99

This Page Intentionally Left Blank.

Appendix B. Unit Conversion Chart

This Page Intentionally Left Blank.

Table B-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (gal) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 gal = 3.78 L 1 L= 0.26 gal 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 gal = 11.35 L 3 L = 0.79 gal 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (cfs)[a]	Cubic Meters per Second (m^3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31cfs	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

This Page Intentionally Left Blank.

Appendix C. State and Site-Specific Standards and Criteria

003. DEFINITIONS

For the purpose of the rules contained in IDAPA 58.01.02, "Water Quality Standards and Wastewater Treatment Requirements," the following definitions apply: (4-5-00)

01. Acute. Involving a stimulus severe enough to rapidly induce a response; in aquatic toxicity tests, a response measuring lethality observed in ninety-six (96) hours or less is typically considered acute. When referring to human health, an acute effect is not always measured in terms of lethality. (3-20-97)

02. Acute Criteria. Unless otherwise specified in these rules, the maximum instantaneous or one (1) hour average concentration of a toxic substance or effluent which ensures adequate protection of sensitive species of aquatic organisms from acute toxicity resulting from exposure to the toxic substance or effluent. Acute criteria will adequately protect the designated aquatic life use if not exceeded more than once every three (3) years. The terms "acute criteria" and "criterion maximum concentration" (CMC) are equivalent. (3-15-02)

03. Acute Toxicity. The existence of mortality or injury to aquatic organisms resulting from a single or short-term (i.e., ninety-six (96) hours or less) exposure to a substance. As applied to toxicity tests, acute toxicity refers to the response of aquatic test organisms to a concentration of a toxic substance or effluent which results in a LC-50. (3-20-97)

04. Beneficial Use. Any of the various uses which may be made of the water of Idaho, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics. The beneficial use is dependent upon actual use, the ability of the water to support a non-existing use either now or in the future, and its likelihood of being used in a given manner. The use of water for the purpose of wastewater dilution or as a receiving water for a waste treatment facility effluent is not a beneficial use. (8-24-94)

05. Available. Based on public wastewater system size, complexity, and variation in raw waste, a certified wastewater operator must be on site or able to be contacted as needed to initiate the appropriate action for normal or emergency conditions in a timely manner.

050. ADMINISTRATIVE POLICY.

01. Apportionment Of Water. The adoption of water quality standards and the enforcement of such standards is not intended to conflict with the apportionment of water to the state through any of the interstate compacts or court decrees, or to interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure, or to interfere with water quality criteria established by mutual agreement of the participants in interstate water pollution control enforcement procedures. (7-1-93)

02. Protection Of Waters Of The State. (7-1-93) **a.** Wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational use in and on the water surface and the preservation and propagation of desirable species of aquatic life; (4-5-00) **b.** In all cases, existing beneficial uses of the waters of the state will be protected. (7-1-93)

03. Annual Program. To fully achieve and maintain water quality in the state, it is the intent of the requirements of the State's Water Quality Management Plan. The Department's planned programs for water pollution control comprise the State's Water Quality Management Plan. (4-5-00)

04. Program Integration. Whenever an activity or class of activities is subject to provisions of these rules, as well as other regulations or standards of either this Department or other Governmental agency, the Department will seek and employ those methods necessary and practicable to integrate the implementation, administration and enforcement of all applicable regulations through a single program. Integration will not, however, be affected to the extent that applicable provisions of these rules would fail to be achieved or maintained unless the Department's role in these cases is limited by state statute or federal law. (7-1-93)

05. Revisions. These rules are subject to amendment as technical data, surveillance programs, and technological advances require. Any revisions made to these rules shall be in accordance with Sections 39-101, et seq., and 67-5201, et seq., Idaho Code. (8-24-94)

051. ANTIDEGRADATION POLICY.

01. Maintenance Of Existing Uses For All Waters. The existing in stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected. (7-1-93)

02. High Quality Waters. Where the quality of the waters exceeds levels necessary to support propagation of fish, shellfish and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the Department finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the Department's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. In allowing such degradation or lower water quality, the Department shall assure water quality adequate to protect existing uses fully. Further, the Department shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and cost-effective and reasonable best management practices for nonpoint source control. In providing such assurance, the Department may enter together into an agreement with other state of Idaho or federal agencies in accordance with Sections 67-2326 through 67-2333, Idaho Code. (7-1-93)

03. Outstanding Resource Waters. Where high quality waters constitute an outstanding national resource, such as waters of national and state parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected from the impacts of point and nonpoint source activities.

053. BENEFICIAL USE SUPPORT STATUS

In determining whether a water body fully supports designated and existing beneficial uses, the Department shall determine whether all of the applicable water quality standards are being achieved, including any criteria developed pursuant to these rules, and whether a healthy, balanced biological community is present. The Department shall utilize biological and aquatic habitat parameters listed below and in the current version of the "Water Body Assessment Guidance", as published by the Idaho Department of Environmental Quality, as a guide to assist in the assessment of beneficial use status. Revisions to this guidance will made after notice and an opportunity for public comment. These parameters are not to be considered or treated as individual water quality criteria or otherwise interpreted or applied as water quality standards. (4-5-00)

01. Aquatic Habitat Parameters. These parameters may include, but are not limited to, stream width, stream depth, stream shade, measurements of sediment impacts, bank stability, water flows, and other physical characteristics of the stream that affect habitat for fish, macroinvertebrates or other aquatic life; and (3-20-97)

02. Biological Parameters. These parameters may include, but are not limited to, evaluation of aquatic macroinvertebrates including Ephemeroptera, Plecoptera and Trichoptera (EPT), Hilsenhoff Biotic Index, measures of functional feeding groups, and the variety and number of fish or other aquatic life to determine biological community diversity and functionality. (3-20-97)

03. Natural Conditions. There is no impairment of beneficial uses or violation of water quality standards where natural background conditions exceed any applicable water quality criteria as determined by the Department, and such natural background conditions shall not, alone, be the basis for placing a water body on the list of water quality limited water bodies described in Section 054. (3-15-02)

054. WATER QUALITY LIMITED WATERS AND TMDLS.

01. After Determining That Water Body Does Not Support Use. After determining that a water body does not fully support designated or existing beneficial uses in accordance with Section 053, the Department, in consultation with the applicable basin and watershed advisory groups, shall evaluate whether the application of required pollution controls to sources of pollution affecting the impaired water body would restore the water body to full support status. This evaluation may include the following: (3-20-97)

> **a.** Identification of significant sources of pollution affecting the water body by past and present activities; (3-20-97)
>
> **b.** Determination of whether the application of required or cost-effective interim pollution control strategies to the identified sources of pollution would restore the water body to full support status within a reasonable period of time; (3-20-97)
>
> **c.** Consultation with appropriate basin and watershed advisory groups, designated agencies and landowners to determine the feasibility of, and assurance that required or cost-effective interim pollution control strategies can be effectively applied to the sources of pollution to achieve full support status within a reasonable period of time; (3-20-97)
>
> **d.** If pollution control strategies are applied as set forth in this Section, the Department shall subsequently monitor the water body to determine whether application of such pollution controls were successful in restoring the water body to full support status. (3-20-97)

02. Water Bodies Not Fully Supporting Beneficial Uses. After following the process identified in Subsection 054.01, water bodies not fully supporting designated or existing beneficial uses and not meeting applicable water quality standards despite the application of required pollution controls shall be identified by the Department as water quality limited water bodies, and shall require the development of TMDLs or other equivalent processes, as described under Section 303(d)(1) of the Clean Water Act. A list of water quality limited water bodies shall be published periodically by the Department in accordance with Section 303(d) of the Clean Water Act and be subject to public review prior to submission to EPA for approval. Informational TMDLs may be developed for water bodies fully supporting beneficial uses as described under Section 303(d)(3) of the Clean Water Act, however, they will not be subject to the provisions of this Section. (3-20-97)

03. Priority Of TMDL Development. The priority of TMDL development for water quality limited water bodies identified in Subsection 054.02 shall be determined by the Director in consultation with the Basin Advisory Groups as described in Sections 39-3601, et seq., Idaho Code, depending upon the severity of pollution and the uses of the water body, including those of unique ecological significance. Water bodies identified as a high priority through this process will be the first to be targeted for development of a TMDL or equivalent process. (3-20-97)

04. High Priority Provisions. Until a TMDL or equivalent process is completed for a high priority water quality limited water body, new or increased discharge of pollutants which have caused the water quality limited listing may be allowed if interim changes, such as pollutant trading, or some other approach for the pollutant(s) of concern are implemented and the total load remains constant or decreases within the watershed. Interim changes shall maximize the use of cost effective measures to cap or decrease controllable human-caused discharges from point and nonpoint sources. Once the TMDL or equivalent process is completed, any new or increased discharge of causative pollutants will be allowed only if consistent with the approved

TMDL. Nothing in this section shall be interpreted as requiring best management practices for agricultural operations which are not adopted on a voluntary basis.

100. SURFACE WATER USE DESIGNATIONS

Waterbodies are designated in Idaho to protect water quality for existing or designated uses. The designated use of a waterbody does not imply any rights to access or ability to conduct any activity related to the use designation, nor does it imply that an activity is safe. For example, a designation of primary or secondary contact recreation may occur in areas where it is unsafe to enter the water due to water flows, depth or other hazardous conditions. Another example is that aquatic life uses may be designated in areas that are closed to fishing or access is not allowed by property owners. Wherever attainable, the designated beneficial uses for which the surface waters of the state are to be protected include: (3-15-02)

01. Aquatic Life. (7-1-93)

a. Cold water (COLD): water quality appropriate for the protection and maintenance of a viable aquatic life community for cold water species. (4-5-00)

b. Salmonid spawning: waters which provide or could provide a habitat for active self-propagating populations of salmonid fishes. (7-1-93)

c. Seasonal cold water (SC): water quality appropriate for the protection and maintenance of a viable aquatic life community of cool and cold water species, where cold water aquatic life may be absent during, or tolerant of, seasonally warm temperatures. (4-5-00)

d. Warm water (WARM): water quality appropriate for the protection and maintenance of a viable aquatic life community for warm water species. (4-5-00)

e. Modified (MOD): water quality appropriate for an aquatic life community that is limited due to one (1) or more conditions set forth in 40 CFR 131.10(g) which preclude attainment of reference streams or conditions.

02. Recreation. (7-1-93) **a.** Primary contact recreation (PCR): water quality appropriate for prolonged and intimate contact by humans or for recreational activities when the ingestion of small quantities of water is likely to occur. Such activities include, but are not restricted to, those used for swimming, water skiing, or skin diving. (4-5-00) **b.** Secondary contact recreation (SCR): water quality appropriate for recreational uses on or about the water and which are not included in the primary contact category. These activities may include fishing, boating, wading, infrequent swimming, and other activities where ingestion of raw water is not likely to occur. (4-5-00)

03. Water Supply. (7-1-93)

a. Domestic: water quality appropriate for drinking water supplies. (4-5-00)

b. Agricultural: water quality appropriate for the irrigation of crops or as drinking water for livestock. This use applies to all surface waters of the state. (4-5-00)

c. Industrial: water quality appropriate for industrial water supplies. This use applies to all surface waters of the state. (4-5-00)

04. Wildlife Habitats. Water quality appropriate for wildlife habitats. This use applies to all surface waters of the state. (4-5-00)

05. Aesthetics. This use applies to all surface waters of the state. (7-1-93)

101. NONDESIGNATED SURFACE WATERS

01. Undesignated Surface Waters. Surface waters not designated in Sections 110 through 160 shall be designated according to Section 39-3604, Idaho Code, taking into consideration the use of the surface water and such physical, geological, chemical, and biological measures as may affect the surface water. Prior to designation, undesignated waters shall be protected for beneficial uses, which includes all recreational use in and on the water and the protection and propagation of fish, shellfish, and wildlife, wherever attainable. (3-23-98)

a. Because the Department presumes most waters in the state will support cold water aquatic life and primary or secondary contact recreation beneficial uses, the Department will apply cold water aquatic life and primary or secondary contact recreation criteria to undesignated waters unless Sections 101.01.b and 101.01c. are followed. (4-5-00)

b. During the review of any new or existing activity on an undesignated water, the Department may examine all relevant data or may require the gathering of relevant data on beneficial uses; pending determination in Section 101.01.c. existing activities will be allowed to continue. (3-23-98) **c.** If, after review and public notice of relevant data, it is determined that beneficial uses in addition to or other than cold water aquatic life and primary or secondary contact recreation are appropriate, then the Department will: (4-5-00) i. Complete the review and compliance determination of the activity in context with the new information on beneficial uses, and (3-23-98) ii. Initiate rulemaking necessary to designate the undesignated water, including providing all necessary data and information to support the proposed designation. (3-23-98)

02. Man-Made Waterways. Unless designated in Sections 110 through 160, man-made waterways are to be protected for the use for which they were developed. (7-1-93)

03. Private Waters. Unless designated in Sections 110 through 160, lakes, ponds, pools, streams and springs outside public lands but located wholly and entirely upon a person's land are not protected specifically or generally for any beneficial use.

This Page Intentionally Left Blank.

Appendix D. Data Sources

Table D-1. Data sources for Beaver-Camas Subbasin Assessment.

Waterbody	Data Source	Type of Data	When Collected
All	Western Regional Climate Center (www.wrcc.dri.edu)	Climate	Period of Record
All	Agrimet Station Data (www.mac1.usbr.gov/agrimet/location.html)	Air	Period of Record
All	Snotel (www.wrcc.dri.edu)	Snow Water Content	Period of Record
Beaver Creek, and Camas Creek	USGS (www.waterdata.usgs.gov/id/nwis/peak)	Streamflow	Period of Record
Beaver Creek, West Camas Creek, and East Camas Creek	USFS-Idaho Falls, Lee Leffert	Temperature	200-2003
Beaver Creek, Stoddard Creek, Camas Creek, Miners Creek, Dairy Creek, Crooked Creek, Threemile Creek, and W. Fk. Rattlesnake Creek	DEQ-Idaho Falls, Melissa Thompson	Temperature	2004
Beaver Creek	BLM-Idaho Falls, Dan Kotanski	Nutrient	2004
Beaver Creek, Ching Creek, Camas Creek, Crooked Creek, Modoc Creek, E.Fk. Rattlesnake Creek, Stoddard Creek, Dairy Creek, Miners Creek, Threemile Creek, and Warm Creek	DEQ-Idaho Falls, Melissa Thompson	Nutrient, Pathogen	2004
All	DEQ-Idaho Falls, Steve Robinson	BURP Monitoring	1993-2004
Beaver Creek and Camas Creek	DEQ-Tech Services, Don Zaroban	McNeil Sediment	2003
Camas Creek	DEQ-Idaho Falls, Melissa Thompson	Streambank Erosion Inventory	2004
See Table 23	DEQ-Idaho Falls, Steve Robinson	Fish	1998, 2001-2004
See Table 25	BLM-Idaho Falls, Pat Koelsch	Fish	1996, 1998, 2000
See Table 26	USFS-Idaho Falls, Jim Capurso	Fish	2002
See Table 23	IDFG-Idaho Falls, Jim Fredericks	Fish	2002
Beaver Creek	BLM-Idaho Falls, Dan Kotanski	PFC	1994 and 2004
Beaver Creek, Camas Creek, Dairy Creek, West Camas Creek, East Camas Creek, Modoc Creek, Threemile Creek, Stoddard Creek, Miners Creek	DEQ-Idaho Falls, Melissa Thompson	Solar Pathfinder	2004

Appendix E. Subsurface Fine Sampling Results

Table E-1. Beaver Creek McNeil Data

Stream Name:	**Beaver Creek**				
Date: (YYYY/MM/DD)	**2003 / 10 / 16**				
Location:	**upper**				
Lat/Long:	N:		**44.4138**	W:	**112.19732**
Lat/Long Accuracy			**5 Meters**		
Datum:	**WGS84**				
Site Desc:	**at Stoddard Creek exit of I-15**				
Personnel:	**M. Thompson, B. Valverde, D. Zaroban**				
Rosgen Channel:					
Reach Gradient:	%				
Geology: (Q G V S)					
Target Species:					
Flow:					
Surrounding Land Use:					

	Core 1 ml	Core 2 ml	Core 3 ml		
Ocular Est% Surf Fines					
Sieve Size (Inches)					
2.5	40	920	720		
1	1720	2605	2830		
0.5	1110	1520	1380		
0.25	37	965	990		
1.0 - 0.25" Subtotal	2867	5090	5200		
#4	5	320	430		
#8	365	490	620		
#20	365	340	370		
#70	365	860	1000		
#270	140	85	90		
<0.25" Subtotal	1240	2095	2510		
Sample Total W/O 2.5"	4107	7185	7710	**Mean**	**Std. Dev.**
% Fines W/O 2.5"	0.301923545	0.29157968	0.325551232	0.3063515	0.0174133
Sample Total W/ 2.5"	4147	8105	8430	**Mean**	**Std. Dev.**
% Fines W/ 2.5"	0.299011333	0.258482418	0.297746145	0.28508	0.0230428

Table E-2. Camas Creek McNeil Data

Stream Name:	Camas Creek

Date: (YYYY/MM/DD)	**2003 / 10 / 21**				
Location:	upper				
Lat/Long:	N:	44.1928		W:	111.9817
Lat/Long Accuracy	5 Meters				
Datum:	WGS84				
Site Desc:	approx. 300 meters above lower end of inventory reach				
Personnel:	R. Lee, D. Zaroban				
Rosgen Channel:					
Reach Gradient:	%				
Geology: (Q G V S)					
Target Species:	rainbow trout				
Flow:					
Surrounding Land Use:	State land, range, grazing				

	Core 1 ml	Core 2 ml	Core 3 ml		
Ocular Est% Surf Fines					
Sieve Size (Inches)					
2.5	530	0	0		
1	4100	2220	2100		
0.5	2780	1295	1090		
0.25	2310	880	820		
1.0 - 0.25" Subtotal	9190	4395	4010		
#4	660	300	260		
#8	1400	600	645		
#20	950	600	470		
#70	2430	1440	1070		
#270	60	70	50		
<0.25" Subtotal	5500	3010	2495		
Sample Total W/O 2.5"	14690	7405	6505	**Mean**	**Std. Dev.**
% Fines W/O 2.5"	0.374404357	0.406482107	0.383551115	0.388146	0.016525
Sample Total W/ 2.5"	15220	7405	6505	**Mean**	**Std. Dev.**
% Fines W/ 2.5"	0.361366623	0.406482107	0.383551115	0.3838	0.022559

Appendix F. Streambank Erosion Inventory Method

Streambank Erosion Inventory

The streambank erosion inventory used to estimate background and existing streambank erosion followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (NRCS, 1983). Using the direct volume method, sub-sections of 1996 §303(d) watersheds were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS Stream Bank Erosion Inventory is a field based methodology, which measures streambank/channel stability, length of active eroding banks, and bank geometry (Stevenson, 1994). The streambank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categories of rating the factors and rating scores are:

Bank Stability:
- Do not appear to be eroding - 0
- Erosion evident - 1
- Erosion and cracking present - 2
- Slumps and clumps sloughing off - 3

Bank Condition:
- Some bare bank, few rills, no vegetative overhang - 0
- Predominantly bare, some rills, moderate vegetative overhang - 1
- Bare, rills, severe vegetative overhang, exposed roots - 2
- Bare, rills and gullies, severe vegetative overhang, falling trees - 3

Vegetation / Cover On Banks:
- Predominantly perennials or rock-covered - 0
- Annuals / perennials mixed or about 40% bare - 1
- Annuals or about 70% bare - 2
- Predominantly bare – 3

Bank / Channel Shape:
- V - Shaped channel, sloped banks - 0
- Steep V - Shaped channel, near vertical banks - 1
- Vertical Banks, U - Shaped channel - 2
- U - Shaped channel, undercut banks, meandering channel - 3

Channel Bottom:
- Channel in bedrock / noneroding - 0
- Soil bottom, gravels or cobbles, minor erosion - 1
- Silt bottom, evidence of active downcutting - 2

Deposition:
- No evidence of recent deposition - 1
- Evidence of recent deposits, silt bars - 0

Cumulative Rating

Slight (0-4) Moderate (5-8) Severe (9+)

From the Cumulative Rating, the lateral recession rate is assigned.

0.01 - 0.05 feet per year	**Slight**
0.06 - 0.15 feet per year	**Moderate**
0.16 - 0.3 feet per year	**Severe**
0.5+ feet per year	**Very Severe**

Streambank stability can also be characterized through the following definition and the corresponding streambank erosion condition rating from Bank Stability or Bank Condition above are included in italics.
Streambanks are considered stable if they do not show indications of any of the following features:

- **Breakdown** - Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*
- **Slumping or False Bank** - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*
- **Fracture** - A crack is visibly obvious on the bank indicating that the block of bank I about to slump or move into the stream. *Bank Stability Rating 2*
- **Vertical and Eroding** - The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Streambanks are considered covered if they show any of the following features:

- Perennial vegetation ground cover is greater than 50%. *Vegetation/Cover Rating 0*
- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*
- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*
- At least 50% of the bank surfaces are protected by logs of 4 inch diameter or larger. *Vegetation/Cover Rating 1*

Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton, 1993). The modification allows for measuring streambank stability in a more objective fashion. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- **Mostly covered and stable (non-erosional).** Streambanks are Over 50% Covered as defined above. Streambanks are Stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative Rating 0 - 4 (slight erosion) with a corresponding lateral recession rate of 0.01 - 0.05 feet per year.*
- **Mostly covered and unstable (vulnerable).** Streambanks are Over 50% Covered as defined above. Streambanks are Unstable as defined above. Such banks are typical of Afalse banks” observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative Rating 5 - 8 (moderate erosion)*

with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.

- **Mostly uncovered and stable (vulnerable).** Streambanks are less than 50% Covered as defined above. Streambanks are Stable as defined above. Uncovered, stable banks are typical of streambanks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and unstable (erosional).** Streambanks are less than 50% Covered as defined above. They are also Unstable as defined above. These are bare eroding streambanks and include ALL banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative Rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Streambanks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection

The first step in the bank erosion inventory is to identify key problem areas. Streambank erosion tends to increase as a function of watershed area (NRCS, 1983). As a result, the lower stream segment of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types) (Rosgen,1996).

Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates are extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically between 10 and 30 percent of streambank needs to be inventoried. Often, the location of some stream inventory reaches is more dependent on land ownership than watershed characteristics. For example, private land owners are sometimes unwilling to allow access to stream segments within their property.

Stream reaches are subdivided into *sites* with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominate bank characteristics change substantially. In a stream with uniform channel geometry there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites. Subdivision of stream reaches is at the discretion of the field crew leader.

Field Methods

Streambank erosion or channel stability inventory field methods were originally developed by the USDA USFS (Pfankuch, 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people and are trained as a group to ensure quality control or consistent data collection. Field crews survey selected stream reaches measuring bank length, slope height, bankfull width and depth, and bank content. In most cases, a Global Positioning System (GPS) is used to locate the upper and lower boundaries of inventoried stream reaches. Additionally, while surveying field crews photograph key problem areas.

Bank Erosion Calculations

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS, 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor.

The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * \ \ _B]/2000 \text{ (lbs/ton)}$$

where:

E = bank erosion over sampled stream reach (tons/yr/sample reach)

A_E = eroding area (ft^2)

R_{LR} = lateral recession rate (ft/yr)

$\ \ _B$ = bulk density of bank material (lps/ft^3)

The bank erosion rate (E_R) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:

E_R = bank erosion rate (tons/mile/year)

E = bank erosion over sampled stream reach (tons/yr/sample reach)

L_{BB} = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al, 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long term average. For example, a 50 year flood event might cause five feet of bank erosion in one year and over a ten year period this events accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding. For example, the bank on the outside of a meander. However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS, 1983). Several techniques are available to quantify bank erosion rates: for example, aerial photo interpretation, anecdotal data, bank pins, and channel cross-sections.
To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates.

The *bulk density* (ρ_B) of bank material is measured ocularly in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

References

Compton, R.R. 1996. Interpretation of aerial photos.

Flanagan, D.C., and M.A. Nearing (Editors). USDA Water Erosion Prediction Project Hillslope Profile and Watershed Model Documentation. NSERL Report No. 10. USDA-ARS National Soil Erosion Laboratory, W. Lafayette IN. 9.1-9.16

Hall, T.J. 1986. A laboratory study of the effects of fine sediments on survival of three species of Pacific salmon from eyed egg to fry emergence. National Council of the Paper Industry for Air and Stream Improvement. Technical Bulletin 482. New York.

IDEQ. 1999b. 1998 303(d) List. Idaho Division of Environmental Quality. Surface Water Program. January. 473 pp.

Leopold, L.B., M.G. Wolman and J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman. San Francisco, CA.

Lohrey, M.H. 1989. Stream channel stability guidelines for range environmental assessment and allotment management plans. U.S. Forest Service, Northwest Region (unpublished).

McNeil W.J. and W.H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. US Fish and Wildlife Service, Special Scientific Report-Fisheries No. 469.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. U.S. Forest Service, Northern Region. Missoula, MT.

Reiser, D.W. and R.G. White. 1988. Effects of two sediment size-classes on survival of steelhead and Chinook salmon eggs. North American Journal of Fisheries Management. 8: 432-437.

Rosgen, D.L. 1996 Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO. 378pp.

Stevenson, T.K. 1994. USDA-NRCS, Idaho. Channel erosion condition inventory description. Memorandum to Paul Shelton, District Conservationist, Montpelier FO, Idaho, 5/24/94: describing estimation of streambank, road and gully erosion.

USDA NRCS. 1983.Channel evaluation Workshop, Ventura, California, November 14-18, 1983. Presented at U.S. Army Corps of Engineers Hydrologic Engineering Center training session by Lyle J. Steffen, Geologist, Soil Conservation Service, Davis, CA. December 14,1982.

USDA FS. 1997. Challis Creek Watershed Analysis. Salmon-Challis National Forest, Challis Ranger District. June 1997.

Appendix G. Streambank Erosion Inventory Data Sheets

This Page Intentionally Left Blank.

Table G-1. Camas Streambank Erosion Inventory Data Sheet

STREAMBANK EROSION INVENTORY WORKSHEET

Stream:	Camas Creek	**Stream Segment Location (DD)**			**Elevation (ft)**
Section:	On BLM property below headwaters	*Upstream:*	44.2666	111.91214	
Date Collected:	10/22/2004	*Downstream*	44.26201	111.91028	
Field Crew:	MCT and TH	**Landuse and Notes:**	Grazing		
Data Reduced By:	MCT				

Streambank Erosion Calculations		
Average Bank Height	5.7	ft
Total Inventoried Bank Length	1863	ft
Inventoried Bank to Bank Length	3726	ft
Erosive Bank Length	1414	ft
Bank to Bank Eroding Segment Length	2828	ft
Percent Eroding Bank	0.758990875	%
Eroding Area	16119.6	ft^2
Recession Rate	0.61	
Bulk Density	90	lb/ft^2
Bank Erosion over Sampled Reach (E)	442.48302	tons/year/sample reach
Erosion Rate (Er)	1254.058157	tons/mile/year
Feet of similar stream type	32155.2	ft
Eroding Bank Extrapolation	51639.00676	ft
Total Streambank Erosion	8079.697193	tons/year

Streambank Erosion Reduction Calculations		
Eroding Area With Load Reductions	4247.64	ft^2
Erosion over sampled reach (with load reduction (20%)	116.59772	tons/yr/sample
Erosion Rate	330.45408	tons/mile/year
Feet of Similar Stream Type	32155.2	ft
Eroding Bank Extrapoltation (with reduction)	13607.28	ft
Total Streambank Erosion	2129.0631	tons/year

Extrapolation goes from HW to 44.245545; 111.93041

Summary for Load Reductions			
Existing		Proposed	
Erosion Rate (t/mi/yr)	Total Erosion (t/y)	Total Erosion (t/yr)	% reduction
1254.058157	8079.697193	2129.063065	73.64922207

This Page Intentionally Left Blank.

Appendix H. Potential Natural Vegetation for TMDLs

Potential Natural Vegetation for Temperature TMDLs

There are a several important contributors of heat to a stream including ground water temperature, air temperature and direct solar radiation. Of these, direct solar radiation is the source of heat that is easiest to control or manipulate. The parameter that affects or controls the amount of solar radiation hitting a stream throughout its length is shade. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Again, the amount of shade provided by objects other than vegetation is not easy to control or manipulate. This leaves vegetation as the most likely source of change in solar radiation hitting a stream.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. We can measure the amount of shade that a stream enjoys in a number of ways. Effective shade, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or estimated visually either on site or on aerial photography. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is that intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in anyway. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides the most shade and the least achievable solar loading to the stream. Anything less than PNV is allowing the stream to heat up from excess solar inputs. We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what can be done to decrease solar gain.

Existing shade or cover will be estimated for entire lengths of streams from visual observations of aerial photos. These estimates can be field verified by measuring shade with solar pathfinders or cover with densiometers at randomly or systematically located points along the stream (see below for methodology). PNV will be determined from existing shade curves developed for similar vegetation communities. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. Existing and PNV shade can be converted to solar load from data collected on flat plate collectors at the nearest weather station collecting these data. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards. Existing shade cannot be greater than PNV shade, thus existing loads cannot be less than PNV loads. PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are considered to be the lowest achievable temperatures (so long as there are no point sources or any other anthropogenic sources of heat in the watershed).

Pathfinder Methodology

The solar pathfinder is a device that allows one to trace the outline of shade producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. In order to adequately characterize the effective shade on a stream, as many of these traces as possible should be taken at systematic or random intervals along the length of the stream in question. At a minimum, five charts should be taken to be averaged to represent shade on a stream reach.

At each sampling location the solar pathfinder should be placed in the middle of the stream about one foot above the water. Follow the manufacturer's instructions (orient to true south and level) for taking traces. Systematic sampling is easiest to accomplish and still not bias the location of sampling. Start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream stopping to take additional traces at fixed intervals (e.g. every 100m, every half-mile, every degree change on a GPS, every 0.5 mile change on an odometer, etc.). On can also randomly locate points of measurement by generating random numbers to be used as interval distances. The more traces the better, for example, if the stream is four miles long paralleled by a road, you could stop at every ¼ mile to take a trace resulting in a good number of traces (about 17). If you stopped at every 0.1 mile interval, you could take over 40 traces.

It is a good idea to take notes while taking solar pathfinder traces, and to photograph the stream at several unique locations. Pay special attention to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade producing ones) are present. Additionally, one can take densiometer readings at the same location as solar pathfinder traces. This provides the potential to develop relationships between canopy cover and effective shade for a given stream.

Appendix I. Aerial Photo Interpretation

Aerial Photo Interpretation

Canopy coverage estimates are provided for 200-foot elevation intervals, or natural breaks in vegetation density, marked out on a 1:100K hydrography. Each interval is assigned a single value representing the bottom of a 10% canopy coverage class as described below (*adapted from the CWE process, IDL, 2000*):

Cover class	Typical vegetation type
0 = 0 – 9% cover	agricultural (ag) land, denuded areas
10 = 10 –19%	ag land, meadows, open areas, clearcuts
20 = 20 – 29%	ag land, meadows, open areas, clearcuts
30 = 30 – 39%	ag land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 –100%	forested

Additionally, a code can be provided to indicate condition or type of vegetation seen at that interval. These codes are as follows:

N = natural forest or larger than a buffer area around stream
B = buffer area around stream, cut or open area with a short distance from stream
C = opening or clearcut on stream itself (stream exposed)
M = meadow/shrubland or alpine type
NA = In some cases no recognizable channel was seen on the photo even though the map shows a stream at 1:100K hydrography. In these few instances we have marked them as NA, no channel visible. Doesn't mean that there is not something down there, we just can't see it.

The visual estimates of cover should be field verified with either a densiometer or a solar pathfinder. The pathfinder measures effective shade and is taking into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The densiometer simply measures the more immediate canopy surrounding the stream. The estimate of cover made visually from an aerial photo does not take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that measurements taken by the two techniques are remarkably similar (OWEB, no date).

Aerial photo estimates likely underestimate spots that have higher cover and overestimate spots that have lower cover, when looking at the entire stream, these discrepancies balance themselves out. (Shumar 2005)

References

IDL. 2000. Forest Practices Cumulative Watershed Effects Process for Idaho. Idaho Department of Lands. March 2000.

Shumar, M. January 20, 2005. Personal Communication. Estimating canopy cover target values via aerial photography.

Appendix J. Canopy Cover Estimates and Targets

Table J-1. Beaver Creek Shade Estimates and Targets

Segment Length (m)	Stream Width (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m2/day)	Potential Load minus Existing load (kWh/m2/day)	
1371 (modoc)	7	0.5	3.08	0.58	2.58	-0.49	Bebb/Geyer Willow Community
1595	7	0.4	3.69	0.58	2.58	-1.11	
965	7	0.3	4.31	0.58	2.58	-1.72	
425	7	0.2	4.92	0.58	2.58	-2.34	
1033	7	0.3	4.31	0.58	2.58	-1.72	
1761	7	0.2	4.92	0.58	2.58	-2.34	
810	8	0.5	3.08	0.5	3.08	0.00	Canyon (narrow)----Bebb/Geyer Willow Community
664	8	0.4	3.69	0.5	3.08	-0.62	
834	8	0.5	3.08	0.5	3.08	0.00	
1236	11	0.2	4.92	0.43	3.51	-1.41	Bebb/Geyer Willow Community
235	11	0.1	5.54	0.43	3.51	-2.03	
1898	11	0.4	3.69	0.43	3.51	-0.18	
745	11	0.2	4.92	0.43	3.51	-1.41	Pathfinder Locations B34-B38
1367	11	0.1	5.54	0.43	3.51	-2.03	
478	11	0.3	4.31	0.43	3.51	-0.80	
1042	11	0.2	4.92	0.43	3.51	-1.41	
972	11	0.5	3.08	0.43	3.51	0.43	
522	11	0.3	4.31	0.43	3.51	-0.80	
467	11	0.2	4.92	0.43	3.51	-1.41	
589	11	0.4	3.69	0.43	3.51	-0.18	
570	11	0.5	3.08	0.43	3.51	0.43	
709	11	0.4	3.69	0.43	3.51	-0.18	
479 (spencer)	11	0.2	4.92	0.43	3.51	-1.41	
1253	11	0.4	3.69	0.43	3.51	-0.18	
879	10	0.6	2.46	0.43	3.51	1.05	
1316	14	0.5	3.08	0.5	3.08	0.00	Canyon-----Dogwood/Yellow Willow/Coyote Willow
7997	14	0.3	4.31	0.29	4.37	0.06	Dogwood/Yellow Willow/Coyote Willow
7851	14	0.2	4.92	0.29	4.37	-0.55	Pathfinder Locations B9-B33
741	14	0.3	4.31	0.29	4.37	0.06	Pathfinder Locations B4-B8
2511	15	0.5	3.08	0.5	3.08	0.00	Pathfinder Locations B1-B3 Canyon-----Dogwood/Yellow Willow/Coyote Willow

	0.34	4.08	0.46	3.34	-0.74	

Table J-2. Camas Creek Shade Estimates and Targets.

Segment Length (meters)	Stream Witdh (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m2/day)	Potential Load minus Existing load (kWh/m2/day)	
1164 (18 mile gauge)	15	0.2	4.92	0.28	4.43	-0.49	Bebb Willow and Geyer Willow Community
368	15	0.1	5.54	0.28	4.43	-1.11	
776	15	0	6.15	0.28	4.43	-1.72	
1637	15	0.1	5.54	0.28	4.43	-1.11	
929	15	0	6.15	0.28	4.43	-1.72	
965	15	0.1	5.54	0.28	4.43	-1.11	
3515	15	0	6.15	0.28	4.43	-1.72	Pathfinder Locations C1-C8
1223	15	0.1	5.54	0.28	4.43	-1.11	
1103	15	0	6.15	0.28	4.43	-1.72	
2152	15	0.1	5.54	0.28	4.43	-1.11	Canyon
2880	15	0.2	4.92	0.28	4.43	-0.49	
803	15	0.1	5.54	0.26	4.55	-0.98	Dogwood/yellow willow/coyote willow
730	15	0.2	4.92	0.26	4.55	-0.37	
5395	15	0.1	5.54	0.26	4.55	-0.98	
681	15	0.2	4.92	0.26	4.55	-0.37	
7551	15	0.1	5.54	0.26	4.55	-0.98	Pathfinder Locations C9-C23
2068	15	0	6.15	0.28	4.43	-1.72	
1748	15	0.1	5.54	0.26	4.55	-0.98	Dogwood/yellow willow/coyote willow
1624	15	0.2	4.92	0.26	4.55	-0.37	
4278	15	0.1	5.54	0.26	4.55	-0.98	
408	15	0	6.15	0.28	4.43	-1.72	
554	15	0.1	5.54	0.28	4.43	-1.11	Pathfinder Locations C24-C27
		0.10	**5.56**	**0.27**	**4.47**	**-1.09**	

Table J-3. Dairy Creek Shade Estimates and Targets.

Segment Length (meters)	Steam Width (m)	Existing Shade	Existing Summer Load ($kWh/m^2/day$)	Target or Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing Load (kWh/day)	
556 (headwaters)	2	0.80	1.23	0.88	0.738	-0.492	Doug Fir/Lodgepole Pine
887	2	0.70	1.85	0.88	0.74	-1.107	
1899	5	0.60	2.46	0.53	2.89	0.4305	Bebb/Geyer Willow
110	5	0.50	3.08	0.53	2.89	-0.1845	Pathfinder Location D5
332	5	0.40	3.69	0.53	2.89	-0.7995	
752	5	0.50	3.08	0.53	2.89	-0.1845	
252	5	0.40	3.69	0.53	2.89	-0.7995	
857	5	0.50	3.08	0.53	2.89	-0.1845	Pathfinder Location D1
217 (mouth)	5	0.40	3.69	0.53	2.89	-0.7995	
		0.50	**3.08**	**0.57**	**2.41**	**-0.46**	

Table J-4. East Camas Creek Shade Estimates and Targets.

Segment Length (meters)	Stream Width (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m2/day)	Potential Load minus Existing load (kWh/m2/day)	
8136 (headwaters)	4	0.7	1.85	0.81	1.17	-0.68	Dougfir/lodgepole pine
1279	4	0.6	2.46	0.81	1.17	-1.29	
698	4	0.5	3.08	0.81	1.17	-1.91	
605	4	0.6	2.46	0.81	1.17	-1.29	
1104	8	0.4	3.69	0.44	3.44	-0.25	Bebb/Geyer Willow community
1170	8	0.3	4.31	0.44	3.44	-0.86	
579	8	0.4	3.69	0.44	3.44	-0.25	

1487	8	0.2	4.92	0.44	3.44	-1.48	
1399	8	0.5	3.08	0.44	3.44	0.37	
3344	8	0.4	3.69	0.44	3.44	-0.25	
997	8	0.5	3.08	0.44	3.44	0.37	
1287	8	0.3	4.31	0.44	3.44	-0.86	
2583	8	0.2	4.92	0.44	3.44	-1.48	
2290 (Camas Creek)	8	0.3	4.31	0.44	3.44	-0.86	
		0.42	**3.56**	**0.55**	**2.79**	**-0.76**	

Table J-5. Modoc Creek Shade Estimates and Targets.

Segment Length (~miles)	Segment Length (meters)	Stream Width (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m2/day)	Potential Load minus Existing load (kWh/m2/day)	
0.5 (west)	838	3	0.6	2.46	0.74	1.60	-0.86	Bebb Willow/Geyer Willow Community
1.4 (middle)	2253	3	0.6	2.46	0.74	1.60	-0.86	
1 (east)	1353	3	0.6	2.46	0.74	1.60	-0.86	
0.3 (mainstem)	573	3	0.6	2.46	0.74	1.60	-0.86	
0.4	555	3	0.5	3.08	0.74	1.60	-1.48	
1.6	3060	5	0.4	3.69	0.61	2.40	-1.29	M1-M5
1	1693	5	0.2	4.92	0.61	2.40	-2.52	
1.3	2373	5	0.3	4.31	0.61	2.40	-1.91	
0.6	1070	5	0.4	3.69	0.61	2.40	-1.29	
0.9	1278	5	0.2	4.92	0.61	2.40	-2.52	
0.6	1181	5	0.4	3.69	0.61	2.40	-1.29	
0.3	1035	5	0.1	5.54	0.61	2.40	-3.14	
0.2	331	5	0.2	4.92	0.61	2.40	-2.52	
0.3	557	5	0.3	4.31	0.61	2.40	-1.91	
Average			**0.39**	**3.78**	**0.66**	**2.11**	**-1.66**	

Table J-6. Threemile Creek Shade Estimates and Targets.

Segment Length (meters)	Stream Width (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m2/day)	Potential Load minus Existing load (kWh/m2/day)	

1266 (East)	3	0.8	1.23	0.83	1.05	-0.18	lodgepole pine/doug fir
1564	3	0.7	1.85	0.83	1.05	-0.80	
858	4	0.6	2.46	0.8	1.23	-1.23	Quaking Aspen/dogwood
1317	4	0.7	1.85	0.8	1.23	-0.62	
3079	4	0.6	2.46	0.8	1.23	-1.23	
788 (Middle)	3	0.7	1.85	0.83	1.05	-0.80	lodgepole pine/doug fir
709	3	0.8	1.23	0.83	1.05	-0.18	
674	4	0.7	1.85	0.8	1.23	-0.62	Quaking Aspen/dogwood
813	4	0.6	2.46	0.8	1.23	-1.23	
2637	4	0.5	3.08	0.8	1.23	-1.85	
990	4	0.6	2.46	0.8	1.23	-1.23	
724 (West)	3	0.7	1.85	0.7	1.85	0.00	Bebb/geyer Willow
899	3	0.5	3.08	0.7	1.85	-1.23	
1681	3	0.1	5.54	0.7	1.85	-3.69	
404	3	0.3	4.31	0.7	1.85	-2.46	
423	3	0.5	3.08	0.7	1.85	-1.23	
2054	3	0.4	3.69	0.7	1.85	-1.85	
990 (mainstem)	5	0.6	2.46	0.53	2.89	0.43	Solar Pathfinder Sites T1-T5
1309	5	0.5	3.08	0.53	2.89	-0.18	
1302	5	0.4	3.69	0.53	2.89	-0.80	
4677	5	0.2	4.92	0.53	2.89	-2.03	
696	5	0.3	4.31	0.53	2.89	-1.41	
		0.54	**2.85**	**0.72**	**1.74**	**-1.11**	

Table J-7. West Camas Creek Shade Estimates and Targets.

Segment Length (m)	Stream Width (m)	Existing Shade (fraction)	Existing Summer Load (kWh/m2/day)	Target or Potential Shade (fraction)	Potential Summer Load (kWh/m2/day)	Potential Load minus Existing load (kWh/m2/day)	
1582 (headwaters)	4	0.6	2.46	0.81	1.17	-1.29	Lodgepole Pine/douglas fir
1301	8	0.5	3.08	0.68	1.97	-1.11	Aspen/dogwood
538	8	0.4	3.69	0.68	1.97	-1.72	

1578	8	0.5	3.08	0.68	1.97	-1.11	
1272	8	0.4	3.69	0.68	1.97	-1.72	
960	8	0.3	4.31	0.68	1.97	-2.34	
2556	8	0.5	3.08	0.68	1.97	-1.11	
4041	8	0.4	3.69	0.68	1.97	-1.72	
1791	8	0.3	4.31	0.68	1.97	-2.34	
951	8	0.2	4.92	0.68	1.97	-2.95	
681	8	0.3	4.31	0.68	1.97	-2.34	
819	8	0.4	3.69	0.68	1.97	-1.72	
485	9	0.3	4.31	0.4	3.69	-0.62	Bebb/geyer Willow Community
771	9	0.2	4.92	0.4	3.69	-1.23	
1568	9	0.3	4.31	0.4	3.69	-0.62	
2626	9	0.5	3.08	0.4	3.69	0.62	
787	9	0.4	3.69	0.4	3.69	0.00	
2431	9	0.3	4.31	0.4	3.69	-0.62	
1192	9	0.1	5.54	0.4	3.69	-1.85	
1832	9	0.2	4.92	0.4	3.69	-1.23	
1617	9	0.1	5.54	0.4	3.69	-1.85	
4894	9	0.2	4.92	0.4	3.69	-1.23	
2259 (Camas Creek)	9	0.3	4.31	0.4	3.69	-0.62	
34691		**0.36**	**3.92**	**0.58**	**2.56**	**-1.36**	

Appendix K. Distribution List

Idaho Falls Public Library 457 Broadway Idaho Falls, ID 83402	William Stewart Idaho Operations Office Environmental Protection Agency 1435 N. Orchard St. Boise, ID 83706
Gerald Messerli, Chairman Continental Divide Watershed Advisory Group	Lee Leffert, Hydrologist James Capurso, Fisheries Biologist Caribou-Targhee National Forest 1405 Hollipark Dr, Idaho Falls, ID 83401
Idaho Department of Lands 3563 Ririe Hwy Idaho Falls, ID 83401	Dan Kotansky, Hydrologist Pat Koelsch, Fisheries Bureau of Land Management 1405 Hollipark Dr. Idaho Falls, ID 83401
Upper Snake River Basin Advisory Group	Water Quality Conservationist Idaho Association of Soil Conservation Districts 315 East 5th North St. Anthony, ID 83445
James P. Fredericks, Regional Fisheries Manager Gary Vecillio, Environmental Specialist Idaho Department of Fish and Game Upper Snake Region 4279 Commerce Circle Idaho Falls, ID 83401 – 2198	Amy Jenkins, Water Quality Analyst Idaho Association of Soil Conservation Districts 1551 Baldy Ave., Ste. #2 Pocatello, ID 83201
Bonneville County NRCS Office Dennis Hadley, District Conservationist 1120 Lincoln Rd. Idaho Falls, ID 83401	Clark County Commissioners
Soil Conservation Commission Kathy Weaver, District Operations Manager 3563 Ririe Hwy Idaho Falls, ID 83402	Soil Conservation Commission Tony Bennett P.O. Box 790 Boise, ID 83701-0790
Environmental Protection Agency Tracy Chellis, Biologist 1200 6th Avenue OW-134	Ron Mitchell Idaho Sporting Congress P.O. Box 1136 Boise, ID 83702

Seattle, WA 98101	
Rick Johnson Idaho Conservation League 710 North Sixth St Boise, ID 83702	

Appendix L. Public Comments

Public Comments and Responses

Comments by the USEPA

Thank you for the opportunity to review the draft Beaver-Camas Subbasin Assessment and Total Maximum Daily Loads (TMDLs) that was released for public comment on March 18, 2004.

The following comments provide some suggestions on changes that would help clarify the draft Subbasin Assessment and TMDLs.

Page 79, Table 20

Table 20 documents two exceedances of the instantaneous measurement for *E. coli* levels for secondary contact recreation at Ching and Modoc Creek. Will DEQ be conducting further sampling or developing a TMDL to address these exceedances?

According to Idaho water quality criteria, an exceedance of the instantaneous maximum criteria for E.coli does not in itself constitute a violation of water quality standards. An exceedance of the geometric mean criteria for *E. coli* is considered a violation. More detailed language regarding Idaho's water quality criteria for *E. coli* has been added for clarification.

In the case of Ching Creek and Modoc Creek, an instantaneous exceedance was documented however, further geometric mean sampling was not conducted. To further address this exceedance, additional *E. coli* sampling will be conducted on Modoc and Ching Creek during the 2005 field season.

Page 97, Conclusions

The Subbasin Assessment contains a recommended de-listing for several intermittent streams or stream segments, however an evaluation of whether the pollutant is impairing beneficial uses is still needed, beyond simply establishing that the stream is intermittent. Idaho water quality standards, IDAPA
58.01.01.070.06 reads:

> "...Numeric water quality standards only apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation, the optimum flow is equal to or greater than five (5) cubic feet per second (cfs). For aquatic life uses, optimum flow is equal to or greater than one (1) cfs..."

This provision makes it clear that numeric standards do not apply below optimum flow levels, however narrative standards, such as sediment, still apply to these waters even when flows are below optimum. Based on this it would be helpful to know the flow for the segments that are being proposed for de-listing to determine if they meet the optimum flow targets for supporting beneficial uses.

The sections Beaver Creek and Camas Creek proposed for sediment de-listing are no longer natural stream channels. Rather they are utilized as complex irrigation systems that show no connectivity to additional streams (closed system). In addition flow data provided for Beaver Creek at Dubois and Camas and flow data provided for Camas Creek at Camas show that both streams rarely meet the optimum flow targets for supporting beneficial uses.

Page 9-12 (TMDL Section), Tables 28-34

These Shade Target Value Charts are a very useful tool for implementation purposes. It might be helpful to include a percent increase of shade needed, for reference.

Information of this nature is provided in Appendix J.

EPA appreciates the opportunity to comment on the draft Beaver-Camas Subbasin Assessment and TMDLs and looks forward to the final submission. If you have any questions regarding the comments on the draft TMDL, please contact me at 206-553-6326.

Sincerely,

Tracy Chellis
TMDL Project Manager

Comments By Idaho Association of Soil Conservation Districts (IASCD)

The following comments, questions, and recommendations are submitted in response to the request by the Idaho Department of Environmental Quality (IDEQ) for comments regarding the Beaver-Camas Creek Subbasin Assessment and TMDL.

Subbasin Assessment

1) Page XX. Do you have good estimates of natural sediment loading in the subbasin that are required to recommend sediment loading targets? Please include the sources you used to calculate natural conditions.

Section 2.4, Biological and Other Data (heading), Streambank Assessments (subheading) states that natural background sediment loading rates for the Beaver-Camas Subbasin were based on literature values showing that 80% bank stability

constitutes natural conditions. Proper citation of the source literature is contained therein.

2) Figures 18-23. Define in the figure captions what the red, yellow and green stream sections represent.

Corrected. Red stream sections are 303(d) listed, yellow stream segments are unlisted, and there are no green sections in the figures.

3) Page 75. Two measurements are not a large enough sample size to determine an outcome. There is no statistical significance.
"A minimum of two measurements must be evaluated before the determination of a violation can be made."

Corrected. Language removed from the document.

4) Page 75-77. If an exceedance of the temperature criteria for cold water aquatic life or an exceedance of the temperature criteria for salmonid spawning warrants a TMDL, then why haven't TMDLs been developed for Miners Creek or Stoddard Creek (perennial streams, Table 17)? It is not clear why TMDLs have not been developed for Miners Creek and Stoddard Creek, since both streams have been reported to sustain flows greater than 1 cfs and Miners and Stoddard Creeks were only measured for flow once on May 3, 2004 (Table 20).

Yes, it is stated in the document that flows greater than one cfs are regularly observed in Miners and Stoddard Creeks however, according to IDAPA 58.01.02.070.06, "Numeric water quality standards only apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated…for aquatic life uses optimum flow is equal to or greater than one (1) cfs". Since numeric exceedances were documented during less than optimal flow (less than 1 cfs), they do not apply. In the absence of additional numeric temperature data, during flows greater than one cfs, a temperature TMDL is not warranted for Miners and Stoddard Creeks.

5) Page 75. It is also unclear why Cow Creek, an ephemeral stream, is listed for unknown pollutants. Whereas, Rattlesnake Creek, an intermittent stream, is not listed even though it exceeds the temperature criteria for cold water aquatic life (W. Fork) and salmonid spawning (main stem). There appears to be inconsistent listing of streams.

IDAPA 58 Title 1 Ch. 2. S.070.06 Application of Standards to Intermittent Waters. Numeric water quality standards only apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated. For recreation, optimum flow is equal to or greater than five (5) cubic feet per second (cfs). For aquatic life uses optimum flow is equal to or greater than one (1) cfs.

As stated in Section 2, Water Quality Concerns and Status, of the document the 303(d) listing process is independent of the TMDL process. The 1998 303(d) list is based on

1993-1996 assessments performed through the Beneficial Use Reconnaissance Program (BURP) and other pertinent material regarding beneficial use status and water quality standards violations. Waters monitored and assessed through BURP after 1996 are not included on the 1998 303(d) list, as approved by the EPA in May 2000.

6) Page 78. E. Fork Rattlesnake Creek exceeds the nutrient criteria for NO3/NO2; however, there has been no listing developed for this creek (continued from above). In addition, the E. Fork Rattlesnake Creek supports Yellowstone Cutthroat trout (Pg. 85- Table 23).

As stated in Section 2.3, Water Column Data (heading), Nutrient Data (subheading), DEQ's narrative water quality criteria state that, "surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growth impairing designated beneficial uses." The numeric nutrient values are EPA guidelines and are not established water quality standards. So, NO3/NO2 values above the EPA suggested value is not an exceedance of state water quality criteria.

2.3, Conclusions (heading), explains why a nutrient TMDL is not necessary for E. Fork Rattlesnake Creek. Although, Nitrate (NO_3) + Nitrite (NO_2) Nitrogen concentrations were above the EPA suggested criteria on East Fork Rattlesnake Creek, visible slime growth and/or nuisance aquatic growth impairing designated beneficial uses were absent. A nutrient TMDL is not necessary for East Fork Rattlesnake Creek since Idaho's narrative water quality criteria for nutrients are met.

As stated in Section 2.3, Biological Data (heading), Fish Data (subheading), the DEQ is aware that E. Fork Rattlesnake Creek supports a Yellowstone Cutthroat trout population.

7) Page 75. Stream temperature data were collected during the summer of 2004, which was a drought year. Is there any way to model what stream temperatures would be during "normal' water years, so that your temperature measurements are not biased by the drought conditions that were occurring during sampling?

Bias occurs when sampling is skewed by human error or erroneous sample design. Elevated stream temperature during a year of low precipitation is not a bias. Stream temperature was accurately recorded with a device that samples hourly with accuracy adequate to portray stream temperature with precision. Water quality standards apply every year, not just when climatic conditions are "ideal". It is important to manage rangeland to adequately shade streams in all years regardless of precipitation levels. The targets for this TMDL are based on shading derived from adequate conditions to provide a thermal buffer to sustain cold water aquatic life in all years, including years with below average precipitation.

Additionally, the DEQ has an extant policy that removes temperature readings that are accumulated on days that are in excess of the 90th percentile of the 10 year average air

temperature. State water quality standards are not based on modeling and extreme temperature is taken into consideration.

8) Table 20. Only one or two measurements were collected for E. coli, nitrate + nitrite, TKN, orthophosphate, and TP at each site and these were collected on different days/months for different sites. We are concerned about your use of one or two measurements to determine that nutrient and E. coli concentrations are meeting or exceeding water quality targets and standards. Are there plans to continue monitoring all of the tributaries to have a more reliable database to work with?

The DEQ is aware that there are limitations to the quantity and frequency of water quality monitoring data presented in this document. However, where this watershed is concerned, low flow conditions (less than one cfs) prohibited sampling after late May at some of the sites listed in table 20. In addition, it must be noted that time and resource constraints prohibit continued and protracted ambient monitoring in every stream in every watershed in Idaho. There are ongoing plans to continue collecting nutrient and pathogen data from streams undergoing BURP monitoring.

9) E. coli levels in Ching and Modoc creeks exceeded the standard for secondary contact recreation, but no TMDLs were written. How do you explain your completion of temperature TMDLs for non-listed streams, but the absence of TMDLs for non-listed streams exceeding E. coli standards?

According to Idaho water quality criteria, an exceedance of the instantaneous maximum criteria for E.coli does not in itself constitute a violation of water quality standards. An exceedance of the geometric mean criteria for *E. coli* is considered a violation. More detailed language regarding Idaho's water quality criteria for *E. coli* has been added to Section 2.3 for clarification.

In the case of Ching Creek and Modoc Creek, an instantaneous exceedance was documented however, further geometric mean sampling was not conducted. To further address this exceedance, additional *E. coli* sampling will be conducted on Modoc and Ching Creek during the 2005 field season.

10) Page 99. The Willow Creek Subbasin is named instead of the Beaver-Camas Subbasin.

Corrected.

11) Page 99. You did not collect data over the course of a year and therefore cannot make the statement that "the bulk of sediment comes from streambank erosion during several weeks of high spring flow."

The statement that "the bulk of sediment comes from streambank erosion during several weeks of high spring flow" is true and can be stated. Based on basic hydrologic and geomorphic principals, it is known that at high stream velocities (occurring during

runoff events) hydraulic stress along stream banks is greatest and the majority of bank scouring occurs at this time. When stabilizing bankside vegetation is removed and bank parent material is exposed the greatest quantity of streambank erosion will occur when stream flows are at or above bankfull discharge.

12) Page 100. Define what is meant by trend data as used in the sentence "Trend data related to grazing impacts is also lacking." What would be measured?

Trend data would be any data collected by an agency that would assist in substantiating an upward or downward trend in land management practices directly related to riparian grazing. It is not the responsibility of the DEQ to explicitly define the mechanism in which land management agencies monitor grazing impacts it is the responsibility of the land management agency to determine that on their behalf.

13) Page 101. There have been several BMPs implemented in the Beaver Camas subbasin. In Madison and Clark Counties, there have been CCRP, EQIP, and SWCA/ACP projects. In Jefferson County, there was an extensive stream stabilization project.

The DEQ contacted the Madison County NRCS and SCC contacts through written and oral means on several occasions to solicit pollution control project information in the watershed. The agencies failed to provide such information for this document. Where information is not provided, it is understood that there must be no data available.

TMDLs

1) Page 8. Does the Upper Salmon River regional curve accurately describe the Beaver-Camas Subbasin? Why was this regional curve used instead of historical quantitative data? The Rosgen 1996 citation is not listed in the main references section.

The Upper Salmon River regional curve is the closest and most representative source of data available for this document. The development of a regional curve specific to this watershed is possible, however time and resource constraints prohibited such an activity. Where precise data, such as a regional curve created for a specific subbasin is not available, the next best available resource must be utilized.

The Rosgen 1996 citation has been incorporated into the main reference section.

2) Page 13. Please specify what the natural background provisions of Idaho water quality standards that will apply are?

It is expected that riparian shading at or around the target value will provide stream temperatures where beneficial uses are supported. It is expected that if potential natural vegetation is achieved and stream temperatures exceed the criteria, beneficial uses will be supported at system potential and therefore the applicable water quality criteria will not apply.

3) Page 15. It is incorrectly stated in the text that Table 29 includes the calculated estimated load for temperature TMDLs – it does not.

Corrected. The calculated estimate load for temperature TMDL is located on table 35.

4) Page 23. It is incorrectly stated in the text that Tables 29 and 30 include sediment load allocations.

Corrected. The load allocations for sediment and temperature are located on tables 35 and 36.

5) Page 23. Temperature load allocation information is not found in Section 2.3 (Subbasin Assessment Pg. 61).

Section 2.3 is utilized for the presentation of water quality monitoring data. Stream temperature and solar pathfinder data is presented in section 2.3 and the TMDL section of the document is where load allocation data is intended to be presented.

6) Page 27. These sites are not described in Section 5.1.
"Nutrient and flow levels should be monitored on Willow Creek (replace with Beaver and Camas Creeks) at the three designated monitoring sites (Section 5.1)."

Corrected. The above mentioned sentence has been removed from the document.

Appendices
1) Appendix E: Subsurface depth fines measured at only one location for Beaver and Camas Creeks. Is this an adequate representation of subsurface fines for these creeks?

Subsurface depth fines were measured at one location in Beaver Creek for two principal reasons 1) limited property access and 2) lack of spawning gravels in areas of the stream where DEQ had approved access. Given these limitations, the one depth fine measurement is the only information available and it is adequate given the time constraints associated with the court ordered TMDL schedule.

Comments from Caribou-Targhee National Forest, Dubois Ranger District

I am writing this letter to make comments on the Beaver-C amas Subbasin Assessment and TMDL. I have read through the document and appreciate the great amount of work and effort that has gone into it.

Initially, I would like to support the proposal to de-list Cow Creek as a 303(d) stream (Executive Summary, pg. xxiii). You note that it is an ephemeral stream, and I would like to add that it has no connectivity to the Beaver Creek drainage. Cow Creek drains into Thunder Gulch which ends in the desert with no connectivity to another stream. I would also like to point out that Table B of the executive summary shows Cow Creek as "List" for recommended changes to the 303(d) list (Executive Summary, pg. xxiv). I assume this is incorrect as it is inconsistent with the previous discussion about Cow Creek.

Corrected. The recommended change to the 303(d) list for Cow Creek is to de-list.

I have one comment regarding high water temperatures in Dairy, East Camas, Modoc, Threemile, and West Camas Creeks. The draft assessment makes a statement about riparian grazing impacting the stream and water quality (Executive Summary, pg. xxiii). Although grazing does take place on all of these streams, grazing use standards are in place and they are monitored regularly by Forest Service personnel to ensure utilization standards are met. All of the streams mentioned also support active beaver complexes. Beaver dams hold water in shallow pools, causing a warming effect. Grazing riparian vegetation may be having some effect on water temperature, but please also make note of the beaver influence as well.

Section 1.2, Subbasin Characteristics (heading), Beaver (subheading) has been added to explain the impacts of beaver activity in the subbasin, particularly the impact of beaver complexes on stream temperatures.

It is true that Beaver, Dairy, East Camas, Modoc, Threemile, and West Camas Creeks support active beaver complexes. Beaver dams do have the potential to increase stream temperatures by reducing stream flows and holding water back in stagnant pools where thermal loading to the stream is higher.

I found a typo in the draft assessment on page 53. The first sentence under subheading <u>2.1 Water Quality Limited Assessment Units Occurring in the Subbasin</u> reads, "There are six water quality limited Assessment units………, and of the five, ………… If I read the table correctly under the same subheading, there are only five units identified.

Corrected. The sentence now reads, "There are six water quality limited assessment units (AU) in the Beaver-Camas Subbasin, and of the six, only the upper halves of two of the listed segments are perennial."

I have some concern regarding table 16, "DEQ temperature data" on page 76 of the draft assessment. There may be nothing that can be done about it at this point, but I question why temperature readings were taken at the Kilgore Road crossing for Threemile and Rattlesnake Creeks. Water tends to pool and stagnate where it crosses the road; and water levels also fluctuate through the season at those locations. Is this representative of those streams? The maximum temperature recorded in Threemile Creek was 85° F, and the average temperature was 68° F. Did water levels get low enough that temperature gauges were literally out of the water for some time?

Later on in the season there were limitations to the placement of the temperature sensors in the stream and they may have been out of the water however, during peak flow (May 2005) gages were submerged and major exceedances in the salmonid spawning criteria were documented in both streams. According to State water quality criteria (IDAPA 58.01.02.070.06), "Numeric water quality standards only apply to intermittent waters during optimum flow periods sufficient to support the uses for which the water body is designated…for aquatic life uses optimum flow is equal to or greater than one (1) cfs". With this standard in place, when stream flows subside to 1 cfs the DEQ attempts to discard that temperature data.

I would also like to make a comment regarding Subsurface Fines (Draft Assessment, pg. 80-81). Because measurements were taken in the fall of 2003, please make note that there were 4 consecutive years of drought prior to these measurements, with less than "normal" spring run off to "flush" fine sediments out of the system.

It is difficult to make that type of assumption regarding the "flush" of fine sediments out of the system. Spring flows over the past four years have had enough stream power to flush fine sediment out of the system. During high flow fine sediments from upstream sources are transported downstream and then re-deposited when spring flows subside. It is important to note that through eliminating upstream sediment sources, less sediment transport and deposition will occur.

The Draft Assessment has a section on streambank assessments (pg. 81-82). Table 22 shows results of a streambank inventory conducted on "upper" Camas Creek. Please be more specific on where this stability rating was conducted.

The streambank erosion inventory was conducted approximately two miles downstream of Eighteenmile on BLM property. This clarification has been added to the document.

On page 100 of the Draft Assessment, in reference to riparian areas a line reads, "Trend data related to grazing impacts is also lacking." A number of long-term trend studies have been installed on Forest Service lands on streams in the Beaver Creek and Camas Creek Assessment area. The following table shows the results of those studies.

Drainage	Vegetative Seral Status	*Vegetative Trend	Greenline Stability Rating
East Threemile Creek	52.4 (Mid Seral)	Stable	6.7 (Moderate)
West Rattlesnake Creek	77.5 (Late Seral)	---	6.3 (Moderate)
Bear Gulch	70.6 (Late Seral)	---	6.6 (Moderate)
Little Creek	68.0 (Late Seral)	Stable	7.1 (Good)
West Camas Creek	78.3 (Late Seral)	Up	8.3 (Good)
Alex Draw Creek	72.7 (Late Seral)	---	7.5 (Moderate)**
Corral Creek	65.1 (Late Seral)	---	5.7 (Moderate)
McGarry Canyon	49.5 (Mid Seral)	---	5.1 (Moderate)
Steel Creek	101.6 (PNC)	---	8.0 (Good)
Stump Creek	100.8 (PNC)	Up	8.9 (Good)
Upper Pete Creek	79.2 (Late Seral)	Stable	7.9 (Good)
Lower Pete Creek	79.1 (Late Seral)	---	8.3 (Good)
Cottonwood Creek	56.8 (Mid Seral)	---	7.1 (Good)
Moose Creek	59.5 (Mid Seral)		6.0 (Moderate)

*Vegetative trend on these riparian areas is only indicated on stream reaches where a previous greenline study existed providing a baseline to compare present vegetation to.
**Alex Draw Creek stability rated out 7.47 which rates "good" based strictly on the stability index. However, the system is in an upward trend and although desired species are present, they are relatively young plants which are not supporting the very erosive soils as well as

they will after a few more years of maturity. Based on professional judgment, this stream is "moderately" stable.

Comment Noted, data will be utilized for implementation monitoring.

I appreciate the chance to comment on the Draft Beaver-Camas Subbasin Assessment and TMDL. I hope this information helps, if you have any questions, please contact myself or Shane Jacobson at the Dubois District office at (208) 374-5422.

Sincerely,

ROBBERT G. MICKELSEN
District Ranger

CC: S.O.

Comments from Jim Hagenbarth, Continential Divide WAG Member

I received a copy of the Draft TMDL for the Beaver-Camas Subbasin Assessment. Gerald Messerli asked that I make any comments that I felt were appropriate. The document is well done and very professional. Some basic comments that I have are as follows:

1) Page 99, 3.1 Sources of Pollutants of Concern. Nonpoint Sources. As one looks at sediment and temperature we must keep in mind the soil types, impediments in the stream that slow down water flow and the quantity of water supplied by the ground water sources. In many of the creeks of interest, there is substantial beaver activity. This has resulted in captive sediments that are released as the dams divert water or are breached during higher flows or due to loss of beaver for various reasons. Also these dams tend to slow flows down and increase water temperature. I have seen this to be the case in other TMDL reports that I have worked with. Please take this into account in this report.

Section 1.2, Subbasin Characteristics (heading), Beaver (subheading) has been added to explain the impacts of beaver activity in the subbasin, particularly the impact of beaver complexes on stream temperatures.

It is true that Beaver, Dairy, East Camas, Modoc, Threemile, and West Camas Creeks support active beaver complexes. Beaver dams do have the potential to increase stream temperatures by reducing stream flows and holding water back in stagnant pools where thermal loading to the stream is higher.

With that said, it must be noted that the temperature TMDLs for this document are based on potential vegetative cover, not stream temperature. This type of temperature

TMDL should make it easier for land managers and owners who have beaver complexes on their property meet the TMDL criteria.

Any reference to vegetative composition in the watersheds and its impact on the water budget and water quantity is totally absent from this report. Charles Kay from Utah State did a vegetative study in this area based on old photography for the US Sheep Experiment Station in the 1990's. He found that there was twice as many brush and conifer acres than in the early 1900's in the Centennial Range. It is common knowledge that conifer encroachment has increased and that conifers have a direct impact on ground water discharges due to evapotranspiration and actual water consumption. As the basal area per acre increases, the ground water discharges decrease dramatically. This in itself could have a huge impact on the quantity of water flowing in the streams of interest and this would directly impact the temperature regimes. It is important that this be taken into consideration in this report as a contributor to the temperature pollutant component and also dewatering. I may be able to find Kay's report if you have any interest.

2) Page 101. Pollution Control Efforts. If this is in reference to the electric fence we put in our deeded land, the correct description is as follows: West Camas Creek, (T13N,R38E, Section 25).

Corrected. It now reads, "We are aware of one private pollution control effort in the drainage consisting of one mile of electric riparian fencing on West Camas Creek (T13N, R38E, section 25)."

3) Page 104, 5.1 In-stream Water Quality targets. See Comment 1, especially vegetative composition of the water shed in regard to the historic range of variation and also the beaver pond and temperature comment.

The information you provided on conifer encroachment and its impacts on groundwater discharges and possible temperature regimes is very informative. However, Idaho's numeric temperature criteria apply when stream flows exceed one cfs regardless of the vegetative community and its potential ancillary impacts on stream temperatures. The numeric criteria do not take into consideration the complexity of factors affecting instream temperatures. Because of this, shade TMDLs have been developed for the Beaver-Camas Subbasin. The temperature TMDL's target values are not based on instream temperature measurements, the targets are based on vegetative potential in the riparian area. Vegetative potential targets allow land managers and owners to focus on riparian management as a means to reduce stream temperatures rather than focusing on numeric values. As stated in the TMDL, when riparian conditions meet the target potential, it will be assumed that stream temperatures will be at their lowest potential based on vegetative shading.

4) Page 128, 5.5 Implementation Strategies. Time Frame. If one recognizes vegetative composition within the watershed and its impact on water quantity, the time frame to influence increased flows through vegetative manipulation would be several years. The enviromentyal activists are intend on forcing a no management mode for public land managing agencies.

Comments noted.

5) Page 129, 5.6 Conclusions. If you accept the impacts of vegetative encroachment and the water budget, it should be included in the conclusion along with the impact of slow moving water as it relates to temperature in Beaver Ponds. You get more surface exposure, consequently more heating.

Answered above.

Hopefully these comments help in your assessment.

Jim Hagenbarth

Jim Hagenbarth

This Page Intentionally Left Blank.